



THE UNIVERSITY OF QUEENSLAND
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**Understanding and Influencing the Maintenance of Physical Activity
and Dietary Behaviour Change in Breast Cancer Survivors**

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Abstract

Background: Maintaining improvements in health behaviours following an intervention is necessary for optimal long-term health outcomes. Extending contact with participants following an initial intervention has been shown to promote maintenance of behaviour change and thus weight loss. Mobile telephone text messaging may be an ideal delivery modality to provide such extended contact. The Living Well after Breast Cancer feasibility weight loss trial provided the opportunity to evaluate a novel text message-delivered extended contact intervention.

Aims and objectives: The primary aim of this thesis was to evaluate the feasibility, acceptability, and efficacy of a text message-delivered extended contact intervention in promoting the maintenance of weight loss and physical activity and dietary behaviour change. Four studies comprised this thesis research. Study One was a systematic review of maintenance outcomes following physical activity and/or dietary behaviour change interventions in breast cancer survivors. Study Two was a text message-delivered pilot study that informed the development of Study Three, the Living Well after Breast Cancer extended contact intervention. Study Four explored the predictors associated with short- and long-term physical activity and dietary behaviour change during the intervention.

Methods and Results:

Study One: A systematic review of physical activity and/or dietary behaviour change interventions in breast cancer survivors was conducted to determine the frequency with which physical activity and dietary maintenance outcomes are reported, and the participant and intervention characteristics associated with successful maintenance outcomes. A structured search of a range of relevant databases yielded a total of 1,298 publications, of which 63 trials were included. Findings indicated few trials reported on post-intervention outcomes (16%), and of those, less than half reported successful maintenance (40%). Few intervention characteristics were identified due to the heterogeneity of studies. Attention needs to be directed towards reporting post-intervention outcomes to inform extended contact intervention development.

Study Two: A pilot study was conducted to determine the acceptability and feasibility of sending text messages to breast cancer survivors. Eight participants (mean age = 49

years) received highly tailored text messages to support physical activity and dietary behaviour change for two weeks. Participants reported high satisfaction, and reported the messages were encouraging and helpful reminders for behaviour change. The intervention was feasible to deliver on a small scale. These pilot findings informed the development of the Living Well after Breast Cancer extended contact intervention.

Study Three: The feasibility, acceptability, and efficacy of the Living Well after Breast Cancer extended contact intervention to promote the maintenance of weight loss and physical activity and dietary behaviour change was evaluated. Participants completed an initial six-month telephone-delivered weight loss intervention (baseline to 6-months), and a six-month text message-delivered extended contact intervention (6- to 12-months), which was followed by a six-month period of no-contact (12- to 18-months). Guided by Social Cognitive Theory, text messages targeted a range of constructs and strategies proposed to be important for maintenance of weight loss and behaviour change. Text messages were individually tailored to participant preferences for timing, content, and frequency. Participants at baseline ($n = 29$) had a mean (SD) age of 55 (8.8) years, BMI of 30.0 (4.2) kg/m^2 , and were recruited a mean of 16.6 (3.2) months post-diagnosis. From baseline to 18-months, participants showed statistically significantly lower mean (95% CI) weight (-4.2kg [-6.0kg, -2.4kg]; $p < 0.001$) and higher physical activity levels (10.4mins/day [3.6mins/day, 17.2mins/day]; $p = 0.003$), but no significant differences in energy intake ($p = 0.200$). Participants elected to receive a mean of eight text messages per fortnight (range 2-11), and reported a high rate of satisfaction. Results suggested a text message-delivered extended contact intervention may support the attenuation of weight regain and promote the maintenance of physical activity.

Study Four: This study evaluated the theoretical constructs and participant characteristics associated with short- and long-term physical activity and dietary behaviour change in participants who completed the Living Well after Breast Cancer extended contact intervention. Findings indicated the importance of comprehensively targeting individual, social, and environmental constructs to promote short- and long-term behaviour change. Specifically, self-efficacy was associated with short- and long-term physical activity change, outcome expectancy and perceived environmental opportunity were associated with long-term physical activity change, and social support was associated with short- and long-term dietary change. Participants who were not employed, did not receive endocrine

treatment, and were more than 12-months post-treatment were most responsive to the intervention. These findings fill a current gap in the literature identifying underlying behaviour change mechanisms that drive maintenance of behaviour change.

Conclusion: This thesis research makes an important contribution to the limited evidence on the development, delivery, and evaluation of interventions to promote maintenance of physical activity and dietary behaviour change. Randomised trials are needed to evaluate comparative-effectiveness and cost-effectiveness of extended contact intervention delivery modalities to promote long-term weight loss and behaviour change.

Declaration by author

This thesis is composed of my original work, and contains no material previously published or written by another person except where due reference has been made in the text. I have clearly stated the contribution by others to jointly-authored works that I have included in my thesis.

I have clearly stated the contribution of others to my thesis as a whole, including statistical assistance, survey design, data analysis, significant technical procedures, professional editorial advice, and any other original research work used or reported in my thesis. The content of my thesis is the result of work I have carried out since the commencement of my research higher degree candidature and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution. I have clearly stated which parts of my thesis, if any, have been submitted to qualify for another award.

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Publications during candidature

Peer-reviewed manuscripts

Spark, L.C., Fjeldsoe, B.S., Eakin, E.G., Reeves, M.M. Efficacy of a text message-delivered extended contact intervention on maintenance of weight loss, physical activity and dietary behavior change. Under review with *Journal of Medical Internet Research*.

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Book chapters

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Conference presentations

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Contributor	Statement of contribution
L Spark (Candidate)	Responsible for formulating the research questions, designing and implementing the extended contact intervention, conducting in-person assessments and data collection for approximately half of the participants at all timepoints, conducting and interpreting the statistical analyses, and writing, editing, and revising the manuscript (40%).
B Fjeldsoe	Assisted in development of research objectives, interpretation of data, and reviewing drafts and subsequent revisions of manuscript. Significant conceptual contribution to design and implementation of the intervention (20%).
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M Reeves	Assisted in development of research objectives, interpretation of data, and reviewing drafts and subsequent revisions of manuscript (20%).

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M Reeves	Assisted in development of research objectives, interpretation of reviewed literature, and reviewing drafts and subsequent revisions of manuscript (20%).
B Fjeldsoe	Assisted in development of research objectives, formulation of methods, interpretation of reviewed literature, and reviewing drafts and subsequent revisions of manuscript (20%).
E Eakin	Assisted in development of research objectives, interpretation of reviewed literature, and reviewing drafts and subsequent revisions of manuscript (20%).

Contributions by others to the thesis

Dr Fjeldsoe, Professor Eakin, and Dr Reeves provided significant input into the conception and content of the thesis. All advisors critically reviewed and provided extensive feedback throughout the candidature. In particular, Dr Fjeldsoe provided considerable guidance with the design and implementation of the extended contact intervention study in this thesis, and input into the review and editing of all chapters. In addition, Dr Elisabeth Winkler provided assistance with statistical analysis and interpretation of data, particularly in relation to Chapter Seven.

Statement of parts of the thesis submitted to qualify for the award of another degree

None.

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List of Abbreviations

BCNA	Breast Cancer Network Australia
BMI	Body Mass Index
CPRC	Cancer Prevention Research Centre
GHS	Get Healthy Service
GHSH	Get Healthy Stay Healthy
HMC	Health Maintenance Consortium
kJ	Kilojoule
LISA	Lifestyle Intervention in Adjuvant Treatment in Early Breast Cancer
mHealth	Mobile Health
MVPA	moderate-to-vigorous physical activity
NWCR	National Weight Control Registry
PA	Physical activity
SCT	Social Cognitive Theory
SMS	Short Message Service
SMS-4-LW	SMS for Living Well
WHEL	Women's Healthy Eating and Living
WINS	Women's Intervention Nutrition Study

CHAPTER 1

INTRODUCTION, CONTEXT, AND OVERVIEW OF THE THESIS

1.1 Introduction

Engaging in regular physical activity and eating a healthy diet are important behaviours related to disease prevention and management in the general population (Kushi et al., 2012), and particularly for women who have had breast cancer (Carmichael et al., 2010; George et al., 2011). Descriptive studies have shown that the period following cancer diagnosis and treatment represents a unique challenge for many survivors as they are no longer closely followed by a team of health professionals (e.g., surgeons, oncologists), yet commonly seek support for healthy lifestyle changes during this time (Basen-Engquist et al., 2012; Demark-Wahnefried et al., 2005; Hewitt et al., 2006). The term ‘breast cancer survivor’ is applied to women from the time of breast cancer diagnosis through the balance of life, regardless of the current stage of treatment or disease (National Cancer Institute, 2011).

There is a large evidence base supporting the efficacy of physical activity interventions in producing short-term behaviour change in breast cancer survivors (Kim et al., 2013; Schmitz et al., 2005; Speck et al., 2010). These intervention studies show that increasing physical activity leads to significant short-term improvements in breast cancer survivors’ quality of life and treatment side-effects (Brown et al., 2011; Ferrer et al., 2011; Loprinzi et al., 2012; Mohammadi et al., 2013a; Schmitz et al., 2005; Speck et al., 2010). A less-developed evidence base supports the efficacy of dietary interventions in breast cancer survivors (Chlebowski et al., 2006; Pierce et al., 2007a), and suggests improvements in quality of life outcomes for women as a result of improved dietary behaviours (i.e., increased fruit and vegetable consumption; decreased fat intake; Mohammadi et al., 2013b; Rock et al., 2002). With the exception of two large scale dietary intervention trials (Chlebowski et al., 2006; Pierce et al., 2007a) and one ongoing weight loss intervention trial (Goodwin et al., 2014), there is a lack of evidence regarding whether short-term improvements in physical activity and dietary behaviours can be maintained in breast cancer survivors, with maintenance being broadly defined here as the evaluation of long-term outcomes, typically occurring after a period of no intervention contact.

Relatively little is known about what drives the maintenance of physical activity and dietary behaviour change; and this is true for the evidence specific to breast cancer survivors, as well as the broader adult population. Emerging evidence suggests that ongoing but less intensive contact following the end of an intervention (such as that delivered by telephone, email or text messaging) may encourage the maintenance of behaviour change (Fjeldsoe et al., 2011; Fry et al., 2009; Jensen et al., 2014), but experimental evaluations of extended contact interventions are few (Middleton et al., 2012). Concurrently, there is strong support to develop interventions that explicitly aim to promote maintenance of behaviour change in breast cancer survivors (Ligibel et al., 2014; Short et al., 2013b; Vallance et al., 2010).

1.2 Context

This PhD was undertaken within the Cancer Prevention Research Centre (CPRC). The PhD research described here brings together two research agendas within the CPRC: (1) the development and delivery of broad-reach physical activity, dietary, and weight loss interventions delivered via telephone counselling and mobile telephone text messaging; and, (2) a focus on breast cancer survivors as a target population. The CPRC evaluated a six-month telephone-delivered weight loss intervention for breast cancer survivors, called the Living Well after Breast Cancer feasibility trial. This trial presented the candidate with the opportunity to develop and evaluate an extended contact intervention delivered via text messaging to promote the maintenance of physical activity and dietary behaviour change following completion of this weight loss feasibility trial. In the context of this thesis, maintenance refers to longer-term improvements that are maintained for at least six months following an initial intensive intervention.

It is important to acknowledge that while the development and evaluation of an extended contact intervention was done in the context of a weight loss intervention, the overall aim of this PhD research was to primarily understand and influence the *maintenance of physical activity* and *dietary behaviour change*. The key focus on *maintenance of behaviour change* is pertinent considering: a) the lack of evidence on long-term physical activity and dietary behaviour change to date; and, b) that favourable health outcomes can occur with long-term physical activity and dietary behaviour change, both dependent and independent of weight loss maintenance (Jensen et al., 2014; National Health and Medical Research Council, 2013). Accordingly, while much of the evidence reviewed in this thesis

will focus on maintenance of physical activity and diet, evidence and findings specifically related to weight loss maintenance will be integrated throughout where it contributes additional value in helping to understand the impact and influences of long-term behaviour change.

1.3 Research aims and objectives

The overall aim of this thesis research was to understand and influence the maintenance of physical activity and dietary behaviour change in breast cancer survivors.

This aim was achieved through four objectives:

Objective 1: To conduct a systematic review of physical activity and/or dietary behaviour change interventions in breast cancer survivors to: (a) determine the frequency with which maintenance of behaviour change outcomes are reported; and, (b) determine the intervention strategies that are common in studies supporting maintenance of behaviour change in this population.

Objective 2: To conduct a pilot study to inform the development of a text messaging intervention to promote maintenance of physical activity and dietary change in breast cancer survivors.

Objective 3: To evaluate the efficacy, feasibility, and acceptability of a text message-delivered extended contact intervention, following the Living Well after Breast Cancer feasibility trial, to promote maintenance of physical activity and dietary behaviour change.

Objective 4: To evaluate the theoretical constructs and participant characteristics associated with short- and long-term physical activity and dietary behaviour change in participants who completed the Living Well after Breast Cancer extended contact intervention.

1.4 Organisation of the thesis

There are eight chapters in this thesis, including this introduction. Chapter Two presents a review of the relevant evidence, and the rationale for investigating health behaviours in breast cancer survivors. Chapter Three includes a systematic review manuscript published in the *Journal of Cancer Survivorship* in 2013, which examines the frequency of reporting of post-intervention maintenance outcomes in physical activity and/or dietary interventions

for breast cancer survivors. Chapter Four presents the findings from a text messaging pilot study conducted with breast cancer survivors which informed the development of the extended contact intervention. Chapter Five is primarily a methods chapter describing the design and development of the extended contact intervention. Chapter Six includes a manuscript on the outcomes from the extended contact intervention, currently under review with the *Journal of Medical Internet Research*. Chapter Seven presents a discussion of the predictors of short- and long-term physical activity and dietary behaviour change in breast cancer survivors that completed the Living Well after Breast Cancer extended contact intervention. Chapter Eight concludes with a summary and integrative discussion of the main findings of the thesis, limitations of this research, public health implications, and directions for future research.

All chapters include an introduction relating to the context of the research, and a statement highlighting the specific objective addressed within the chapter. Chapters conclude with a summary of the findings in relation to the existing evidence, and discuss implications with reference to the contribution of the findings to the overall aim of the thesis.

1.5 Significance of this research

There have been numerous calls in the literature to better understand how to promote maintenance of behaviour change in order to inform evidence-based practice that will lead to sustained health benefits (Chaudhry et al., 2013; Crain et al., 2010; Lawler et al., 2014; Ramage et al., 2014). Maintenance of behaviour change is particularly important for cancer survivors, as they are at an increased risk (compared to those without cancer) for cancer recurrence and mortality, weight gain, as well as a range of lifestyle-related chronic conditions (Ballard-Barbash et al., 2012; Ewertz et al., 2011; Griffiths et al., 2014; Land et al., 2012). However, little empirical evidence is available to address this often cited need. This thesis research advanced the evidence base by:

- (1) contributing to the limited intervention evidence reporting on maintenance of behavioural and weight outcomes following the end of a weight loss intervention in breast cancer survivors;
- (2) understanding the efficacy, feasibility, and acceptability of text messaging as a modality for delivering extended contact to support the maintenance of physical activity and dietary behaviour change;

- (3) advancing the evidence on understanding the underlying theoretical constructs important for short- and long-term physical activity and dietary behaviour change; and,
- (4) informing the development of future behaviour change interventions targeting breast cancer survivors and also the broader population.

CHAPTER 2

LITERATURE REVIEW

2.1 Health behaviour change in breast cancer survivors

2.1.1 Breast cancer survivors in Australia

The number of new breast cancer diagnoses in Australian women more than doubled in the 26 year period from 1982 to 2008 (Australian Institute of Health and Welfare & Cancer Australia, 2012). There are currently more than 159,000 breast cancer survivors in Australia, and more than 13,000 additional women are diagnosed each year; this equates to 37 women being diagnosed with breast cancer every day (Australian Institute of Health and Welfare & Cancer Australia, 2012). The number of breast cancer survivors is increasing in Australia, primarily due to improvements in early detection and treatment, and five year survival rates are now over 89% (Australian Institute of Health and Welfare & Cancer Australia, 2012). Although the long-term prognosis for breast cancer survivors is promising, survivorship is associated with risk of cancer recurrence and mortality, weight gain, and comorbid chronic disease (Ballard-Barbash et al., 2012; Ewertz et al., 2011; Griffiths et al., 2014; Land et al., 2012). Thus, there is an imperative need for increased attention to be directed to the improvement of health-related outcomes for breast cancer survivors.

2.1.2 Health behaviour guidelines for breast cancer survivors

Cancer prevention and survivorship guidelines worldwide recommend that cancer survivors: be physically active at a moderate intensity for at least 30 minutes every day; aim to eat two serves of fruit and five serves of vegetables each day; and, maintain a healthy body mass index (BMI) between 18.5 and 25 kg/m² (American Cancer Society, 2011; Rock et al., 2012; The Cancer Council Australia, 2013; World Cancer Research Fund International, 2014). However, figures indicate that more than half of Australian breast cancer survivors do not meet the recommended levels of physical activity at six months post-diagnosis (Harrison et al., 2009), and it is proposed a similar proportion do not consume the recommended fruit and vegetable intake (Milliron et al., 2014) and have poor quality diets (Potter et al., 2014). Furthermore, approximately 60% of Australian

women diagnosed with breast cancer are overweight or obese at six months post-diagnosis (Hayes et al., 2008).

2.1.3 Physical activity, diet, and breast cancer survival

Breast cancer survivors experience significant health benefits from engaging in regular physical activity, over and beyond the benefits that are well established in the general population (e.g., lower hypertension, reduced cholesterol levels, improved risk of chronic disease; Carnethon et al., 2010; Choo et al., 2010; Haskell et al., 2007; Kim et al., 2013; Parker et al., 2007; Sabiston et al., 2011; Warburton et al., 2006). Cohort studies suggest that, independent of obesity status, breast cancer survivors engaging in a level of physical activity in line with recommended guidelines (at least 150 minutes/week) have a significantly lower risk of death from all-cause and breast-cancer specific mortality, as well as a reduced risk of recurrence (Beasley et al., 2012; Holmes et al., 2005; Ibrahim et al., 2011; Schmid et al., 2014). However, the survival benefits of post-diagnosis physical activity have yet to be demonstrated in a randomised controlled trial.

Evidence on the relationship between breast cancer recurrence and mortality with dietary behaviours is far less developed than that for physical activity. Two large-scale randomised controlled dietary behaviour change intervention trials have evaluated the effect of diet on cancer recurrence and survival in breast cancer survivors and report mixed findings (Chlebowski et al., 2006; Pierce et al., 2007a). In brief, Chlebowski and colleagues (2006) found that reducing dietary fat intake may improve survival outcomes, while Pierce and colleagues (2007) found adopting a diet very high in vegetables, fruit, and fibre, and low in fat did not impact survival outcomes. However, the majority of cohort studies examining various indicators of diet quality (e.g., fruit and vegetable, fat, fibre intake) report a modest protective effect on survival (Beasley et al., 2011; Kroenke et al., 2005; Kwan et al., 2009; McEligot et al., 2006; Rock et al., 2002; Vrieling et al., 2013).

2.1.4 Weight and breast cancer survival

Excess body weight is a well-established risk factor for post-menopausal breast cancer (Chan et al., 2014; World Cancer Research Fund International, 2014), and most patients diagnosed with breast cancer are overweight at time of diagnosis (Hayes et al., 2008; Pekmezi et al., 2011). Weight gain and adverse body composition changes are common during breast cancer treatment, particularly among those who receive adjuvant

chemotherapy (Bicakli et al., 2014; Hayes et al., 2008; Irwin et al., 2005; Liu et al., 2014). As in the general population, overweight and obese breast cancer survivors are at increased risk of co-morbidities, such as type 2 diabetes and cardiovascular disease (Goodwin et al., 2012; Patterson et al., 2010). International and Australian data indicate that 43% of breast cancer survivors have at least one co-morbid condition (Patterson et al., 2010; Thompson et al., 2008). There is also strong epidemiological evidence to suggest that excess body weight is associated with up to a two-fold increased risk of cancer recurrence and death from breast cancer-specific and all-cause mortality (Chan et al., 2014; Ewertz et al., 2011; Kamineni et al., 2013; Protani et al., 2010). Weight management through physical activity and dietary behaviour change is therefore likely to be important for reducing risk of chronic disease and improving recurrence and survival outcomes in breast cancer survivors.

2.1.5 Physical activity and diet interventions in breast cancer survivors

There is a vast body of evidence on the efficacy of interventions to promote physical activity initiation in breast cancer survivors (Kim et al., 2013; Schmitz et al., 2005; Speck et al., 2010). Reviews of these controlled physical activity trials report small to moderate intervention effect sizes for physical activity level, aerobic fitness, muscular strength, and overall physical functioning in breast cancer survivors both during and post-treatment (Kim et al., 2013; Schmitz et al., 2005; Speck et al., 2010). Reviews also provide support for the efficacy of physical activity behaviour change interventions in significantly improving a range of quality of life indicators (e.g., anxiety, self-esteem, depression, body image) and treatment-side effects (e.g., fatigue; Ferrer et al., 2011; Kim et al., 2013; Loprinzi et al., 2012). This literature suggests it is possible to change physical activity of breast cancer survivors in the short term, and that this is beneficial for their health.

A limited number of randomised controlled trials have targeted dietary behaviour change in breast cancer survivors, including only two large-scale randomised controlled trials examining diet in relation to survival outcomes. The Women's Healthy Eating and Living (WHEL) study reported that while survivors in the intervention group adopted a diet that was significantly higher in vegetables, fruit and fibre, and lower in fat than the control group, the intervention did not reduce breast cancer recurrence or mortality during a 7.3 year follow-up period (Pierce et al., 2007a). In contrast, the Women's Intervention Nutrition Study (WINS) reported the beneficial impact of a dietary intervention in reducing dietary fat

intake on breast cancer recurrence after five years follow-up (Chlebowski et al., 2006). The WINS study also reported the intervention had a modest influence on weight loss at five years follow-up, suggesting weight loss potentially mediates the effect of diet on survival outcome (Chlebowski et al., 2006). In summary, there is limited evidence to suggest it is possible to change dietary behaviours in breast cancer survivors, and that this change may lead to improved health (Aragon et al., 2014).

2.1.6 Weight loss interventions in breast cancer survivors

Despite the common risk of weight gain following treatment for breast cancer, only a small number of trials have evaluated the efficacy of weight loss interventions for women with breast cancer. A recent systematic review of weight loss trials in breast cancer survivors reported a total of 10 randomised controlled trials and four single-arm trials have evaluated interventions of two to 18 months in duration, with approximately half reporting mean successful weight loss of at least 5% at end-of-intervention (Reeves et al., 2014). Of the two trials that reported maintenance outcomes following end-of-intervention, one reported ongoing weight loss at three-months follow-up (Campbell et al., 2012) while the other reported nearly half of initial weight loss was regained at six-months follow-up (Greenlee et al., 2013). The recently published Lifestyle Intervention in Adjuvant Treatment of Early Breast Cancer (LISA) trial randomised breast cancer survivors to a two-year weight loss intervention and reported participants lost an initial 5.3% of weight at six-months, but regained 65% of initial weight loss by two-years follow-up (Goodwin et al., 2014). There is support for the efficacy of behaviour change interventions in successfully initiating weight loss in breast cancer survivors, but less is known about how to promote successful longer-term weight loss maintenance.

In the cancer survivor literature, there have been numerous calls for research attention to the evaluation of behavioural, weight, and quality of life outcomes after the end of interventions (Ligibel et al., 2014; Reeves et al., 2014; Stull et al., 2007; Vallance et al., 2010; Vallance et al., 2008). With the exception of the LISA weight loss trial (Goodwin et al., 2014) and the WINS (Chlebowski et al., 2006) and the WHEL (Pierce et al., 2007a) dietary intervention trials, in which intervention contact continued (albeit at a reduced intensity) and follow-up assessments were conducted up to seven-years follow-up, there have been few studies reporting on maintenance of effects following an initial intervention (Reeves et al., 2014). It is promising to see maintenance is being addressed in a number

of currently ongoing long-term weight loss trials for breast cancer survivors, but these results are withstanding to date (Rack et al., 2010; Rock et al., 2013; Villarini et al., 2012). Due to the limited evidence base to date reporting on maintenance of weight loss and physical activity and dietary behaviour change in breast cancer survivors, little is known about long-term maintenance of behaviour change in this population (Chaudhry et al., 2013). This literature review will therefore draw upon findings from the broader evidence base assessing maintenance of weight loss and physical activity and dietary behaviour change in a diverse range of adult populations to address existing gaps in the literature.

2.2 Maintenance of physical activity and dietary behaviour change

2.2.1 Definition of maintenance of physical activity and dietary behaviour change

Defining maintenance of behaviour change remains a challenge for researchers due to the lack of attention to date (Seymour et al., 2010). Maintenance of physical activity behaviour change has most commonly been defined as continuing to engage in regular physical activity for at least six months after the end of an intervention (Crain et al., 2010; Pekmezi et al., 2011; Vallance et al., 2010; Van Stralen et al., 2010). Dietary interventions reporting maintenance of behaviour change similarly report on six month post-intervention outcomes, although a number of physical activity and dietary studies report 'maintenance' after only two or three months post-intervention (Fjeldsoe et al., 2011; Seymour et al., 2010). A six month post-intervention timeframe is consistent with the more established evidence base for defining 'short-term' weight loss maintenance (Abildso et al., 2014; Carels et al., 2014; Elfhag et al., 2005), while researchers evaluating 'long-term' weight loss maintenance apply a more conservative maintenance timeframe of 12 months post-intervention (Barte et al., 2010; Clifton et al., 2014; Dombrowski et al., 2014; Ramage et al., 2014).

Despite some consensus about the use a minimum six month post-intervention timeframe to report maintenance of behaviour change, there is less clarity about the *amount* of sustained behaviour change that indicates successful maintenance. Some studies assess maintenance relative to an individual's baseline levels, while others report maintenance based on a known behavioural guideline or pre-determined criterion being achieved at both end-of-intervention and maintenance assessments (e.g., less than 5% change post-intervention; Dombrowski et al., 2014; Jensen et al., 2014; Ramage et al., 2014; Seymour

et al., 2010). Inconsistencies remain in the amount of change required to define successful maintenance of behaviour change.

With the aim to accelerate the understanding and application of long-term behaviour change interventions, the National Institutes of Health in the United States funded the development of a collaborative research group to promote the study of behaviour change maintenance, the Health Maintenance Consortium (HMC; Nilsen et al., 2010). The HMC defined maintenance of behaviour change as the continuation of behaviour after the end of an intervention that meets a threshold believed to be necessary to improve health (Seymour et al., 2010). This definition draws on the current evidence base across multiple behaviours and is intended to be applicable to a range of behaviours (i.e., physical activity, diet/nutrition, smoking cessation, and substance abuse; Seymour et al., 2010).

Given the limited number of physical activity ($n = 6$) and diet/nutrition ($n = 6$) studies selected for review in the development of the HMC definition, within-behaviour comparisons were not feasible (Seymour et al., 2010). Thus, the HMC were unable to prescribe a specific reporting period, or a specific amount of change, that is indicative of maintenance of physical activity or dietary behaviour change. Taking into account the ambiguity in this field and the evidence to date, successful maintenance in this thesis refers to longer-term sustained improvements that are maintained for at least six months following an initial intensive intervention. Specifically, this thesis will address maintenance outcomes six-months and 12-months following an initial intensive intervention.

2.2.2 Reporting of physical activity and dietary behaviour change maintenance outcomes

The evidence to date on maintenance of behaviour change in the broader intervention literature is limited due to the majority of physical activity and dietary behaviour change studies failing to conduct assessments of behavioural outcomes beyond the end of an intervention (Barte et al., 2010; Brantley et al., 2008; Fjeldsoe et al., 2011; Gurlan et al., 2011). A meta-analysis of physical activity interventions among obese populations indicated only 20% of studies (9 of 46 studies) included an assessment of physical activity post-intervention follow-up, and this period of follow-up ranged from three to 18 months (Gurlan et al., 2011). A systematic review of maintenance of physical activity and dietary behaviour change interventions in adults reported 35% of trials (55 of 157 trials) assessed behavioural outcomes at least three months post-intervention (Fjeldsoe et al., 2011).

Despite the limited number of studies that report on post-intervention outcomes, there is strong consensus in the behaviour change literature that researchers should conduct follow-up assessments beyond the end of the initial intervention (Gerber et al., 2009; Gourlan et al., 2011; Riebe et al., 2005; Tate et al., 2007; Turk et al., 2009; Vallance et al., 2010; Wing et al., 2008).

2.2.3 Patterns of physical activity and dietary behaviour change maintenance outcomes

Across all behavioural domains, it is well-established that initial behaviour change will often decline when the intervention is reduced or terminated (Artinian et al., 2010; Jensen et al., 2014). Research suggests that only 50% of people who initiate an exercise program will continue to engage in the behaviour for more than six months (Fletcher et al., 1996). Initiating dietary behaviour change is notoriously difficult, but maintaining these changes long-term have been recognised as even more challenging (Christie, 2010; Wing et al., 2001). Evidence from the weight loss literature indicates that weight regain post-intervention has been estimated to be in the order of 0.3kg per month (Dansinger et al., 2007), with 50% or more of participants likely to have returned to their baseline weight within one to five years post-intervention (Curioni et al., 2005; Riebe et al., 2005; Wadden et al., 2004). The difficulty in maintaining weight loss long-term has been heavily attributed to the failure in maintaining changes to physical activity and diet (Jensen et al., 2014; Thomas et al., 2014). Given maintenance of physical activity and dietary behaviour change is required for weight loss maintenance and for long-term health benefits, the difficulty in maintaining these behaviour changes long-term is concerning and problematic (Chaudhry et al., 2013; Jensen et al., 2014). There is a clear gap in the evidence and subsequent need to direct attention to understanding the interventions that promote maintenance of behaviour change (Akers et al., 2010; Fjeldsoe et al., 2011; Fjeldsoe et al., 2012; Gourlan et al., 2011; Turk et al., 2009; Van Stralen et al., 2009).

2.3 Interventions targeting maintenance of physical activity and dietary behaviour change and weight loss

2.3.1 Extended contact in physical activity and dietary interventions

Two systematic reviews have concluded that extended contact in a 'maintenance phase' of an intervention (i.e., separate to the 'initial phase' but still considered part of the intervention) is common among trials reporting successful maintenance of physical activity

and dietary behaviour change at post-intervention follow-up (Artinian et al., 2010; Fjeldsoe et al., 2011). Continued contact after initial behaviour change is thought to influence maintenance by prompting awareness and reinforcing behaviour change skills adopted during the initial intervention (Artinian et al., 2010; Fjeldsoe et al., 2011). Artinian and colleagues (2010) concluded that continuing contact for at least four months after the end of the initial intervention was common among studies reporting successful maintenance of physical activity and dietary behaviour change at 12 months post-intervention follow-up. The majority of the studies included in these reviews delivered the initial intervention via face-to-face and/or telephone counselling, and then delivered the extended contact via face-to-face, telephone counselling, print materials, or a combination of these. Only one of these studies randomised participants to extended contact (telephone and newsletter vs. newsletter only) at the end of the initial intervention, but this study did not include a no-contact control group during the follow-up period (Albright et al., 2005).

Three other studies have randomised participants following a physical activity intervention into extended contact (Butler et al., 2009; Goyder et al., 2014; Hughes et al., 2010). Butler and colleagues (2009) reported maintenance of change in physical activity four months post-intervention was more successful in a group of cardiac rehabilitation patients that received continued face-to-face contact over six weeks, compared to a no-contact group. Hughes and colleagues (2010) reported maintained frequency of physical activity was significantly more likely among older adults who received face-to-face and telephone-delivered extended contact for 16 months following the end of an initial two month intervention, compared to face-to-face extended contact group. In contrast, Goyder and colleagues (2014) randomised adults to face-to-face extended contact, telephone extended contact, or no-contact following a three month physical activity intervention and reported no significant differences between the groups in physical activity at three months post-intervention. In conclusion, reviews of maintenance of physical activity and dietary behaviour change evidence suggest that extended contact during a maintenance phase is important, but this has not been experimentally tested compared to a no contact control group with a minimum six month post-intervention evaluation.

2.3.2 Extended contact in weight loss interventions

Reviews of long-term weight loss maintenance suggest that extended contact interventions are common among trials achieving weight loss maintenance (Jeffery et al.,

2000; Middleton et al., 2012; Perri, 1998). A review and meta-analysis of extended contact weight loss interventions delivered via telephone or face-to-face reported significantly less weight was regained in the extended contact groups compared to no-contact control groups, with participants in extended contact intervention groups regaining 3.2kg less than control groups over approximately 18 months follow-up (Middleton et al., 2012). Findings from systematic reviews exploring internet-delivered extended contact weight loss maintenance interventions report mixed findings in terms of maintenance intervention modality effectiveness (Neve et al., 2010; Turk et al., 2009). One pilot study to date has explored the effectiveness of a six-month telephone-delivered extended contact intervention on the maintenance of weight loss in breast cancer survivors following an initial telephone-delivered or face-to-face intervention (Harris et al., 2013). Contrary to expectations, findings revealed significantly better weight loss maintenance in participants who received a telephone-delivered extended contact intervention compared to face-to-face (Harris et al., 2013). The authors propose participants who received the initial face-to-face intervention may have experienced difficulties adjusting to the change in delivery modality during the extended contact intervention (Harris et al., 2013).

In the absence of no-contact control groups and comparative effectiveness studies, the efficacy of different extended contact intervention delivery modalities remains unclear. However, extended contact via face-to-face or over the telephone is commonly reported as costly and time consuming (Donnelley et al., 2013; Radcliff et al., 2012), while the passive nature of web- and print-based contact can lead to poor participant retention and engagement (Neve et al., 2009; Kodama et al., 2012). Concurrently, there is strong support in the literature to develop extended contact interventions that are cost-effective, innovative, and broad-reach (Dombrowski et al., 2014). Extended contact has now been reported to be best practice for promoting successful maintenance of behaviour change, but there is limited evidence to support efficacious delivery modalities (Middleton et al., 2012; Sniehotta et al., 2014).

2.4 Health behaviour change interventions delivered via text message

2.4.1 Overview

With an estimated seven billion mobile phone subscriptions currently worldwide, the number of individuals with mobile phones is fast approaching the number of people on

earth (International Telecommunication Union, 2014). A total of 30 million people subscribed to mobile phone services in Australia in 2014, this accounting for four mobile services to every three people in Australia (Australian Communications and Media Authority, 2012). Text messages are an economical and widely used method of using a mobile phone to communicate. A text message is a short written message, usually limited to 160 characters, sent from one mobile phone to another or from an operator to a mobile phone via the Short Message Service (SMS). More than 80% of mobile phone subscribers in Australia are active text message users (Australian Communications and Media Authority, 2012). Text messaging is emerging as a feasible modality to deliver programs that educate, support, and facilitate prevention and self-management of chronic disease (De Jongh et al., 2012; Fjeldsoe et al., 2009; Jones et al., 2014; Vodopivec-Jamsek et al., 2012).

Text messaging is an attractive broad-reach modality to promote healthful behaviours for numerous reasons. The 'digital divide' along the socioeconomic gradient is less pronounced in mobile phone use when compared with other communication technologies, such as Internet access (Free et al., 2013; International Telecommunication Union, 2014). Text messages can be delivered at a lower cost than postal, phone, or face-to-face communication (Free et al., 2013). Asynchronous communication (where the sender and receiver are not necessarily concurrently engaged in conversation), such as via text messaging, reduces participant burden because the recipient can choose to access the message when most convenient for them (Free et al., 2013). Text messaging can develop a 'virtual personal relationship' between recipient and sender that enables interactivity and accountability without the necessity of 'voice-to-voice' contact (Free et al., 2013). Text messaging is also an unobtrusive method of reminding people to monitor and report on their behaviour, which can provide a critical opportunity for feedback tailored to recent success or failures (Fjeldsoe et al., 2012).

2.4.2 Initial behaviour change interventions delivered via text message

An increasing number of text message-delivered interventions have been used to support short-term physical activity and dietary behaviour change (Fjeldsoe et al., 2010b; Johnston et al., 2014; Maddison et al., 2014; O'Reilly et al., 2013; Prestwich et al., 2010; Spring et al., 2012) and weight loss in adults (Haapala et al., 2009; Patrick et al., 2009; Shaw et al., 2012; Siopis et al., 2014). A plethora of recent systematic reviews provide further support

for the short-term efficacy of text message-delivered interventions across different health behaviours among different age groups and populations (Head et al., 2013; Jones et al., 2014; Mason et al., 2014; Poorman et al., 2014; Saffari et al., 2014; Whittaker et al., 2009). A professional network called 'mobile persuasion' has also been established for researchers and practitioners dedicated to furthering the evidence base for using text messaging for health promotion practice (Fogg et al., 2008). This organisation regularly holds conferences for researchers across industries including health, social networking, and advertising to explore how mobile technology can be used to change behaviour.

2.4.3 Extended contact interventions delivered via text message

There are benefits of text messaging that are specific to its use for promoting maintenance of behaviour change. Text messaging delivery systems and automated databases enable the efficient delivery of individualised and tailored messaging suited to the context of interventions delivering extended contact over long periods. Text messaging implements 'push' technology, where information is received without requiring a user-initiated request, such as a user logging onto a website (Fjeldsoe et al., 2012). This is important as participants are less likely to disengage from continued intervention contact if they are not required to actively seek support (Fjeldsoe et al., 2012). Text messaging can also reach people in a place and at a time that is most meaningful for maintenance of behaviour change, and this timing can be tailored to the individual (Fjeldsoe et al., 2012). This advantage may be particularly relevant in maintaining behaviour change where lifestyle decisions rendering success or failure of maintenance are made continuously throughout the day (Rothman et al., 2009). This is important in an extended contact delivery modality because the maintenance of behaviour change may require real-time prompting of habitual behaviours (Free et al., 2013). Text messaging presents as a broad-reach, efficient intervention modality potentially suited to foster the maintenance of weight loss and behaviour change (Shaw et al., 2013).

One study has used text messaging to support the maintenance of behaviour change among African-American women following a six month weight loss intervention (Gerber et al., 2009). This text messaging maintenance intervention was implemented after participants in the pilot study suggested that receiving text messaging could provide helpful reminders to engage in behaviours important for weight control. At the end of the group-based face-to-face initial intervention, participants opted-in to receive personalised

or general text messages over a four month period. The authors reported high participant acceptability of the maintenance phase intervention, but maintenance outcomes related to weight and behavioural change were not reported in this study (Gerber et al., 2009).

Two more recent studies reported on short-term outcomes following a text message-delivered extended contact intervention. Following an initial 12-week face-to-face weight loss intervention, Donaldson and colleagues (2014) reported that a 12-week text message-delivered extended contact intervention promoted further short-term improvements in weight loss and physical activity and dietary outcomes, with intervention participants reporting a further mean weight loss of 1.6kg compared to mean regain of 0.7kg in a retrospective no-contact control group (Donaldson et al., 2014). Shaw and colleagues (2013) randomised participants who had lost at least 5% weight loss following a commercially available weight loss program to one of three text message-delivered extended contact interventions, and found 87% of participants self-reported less than 3% weight change at one-month and three-month follow-up (Shaw et al., 2013). These studies provide support for the feasibility and acceptability of a text message-delivered extended contact intervention to promote healthy behaviours for *short-term* weight maintenance.

A study by Fjeldsoe and colleagues (2014) is currently investigating the effectiveness of a longer-term randomised six-month text message-delivered extended contact intervention following a six-month telephone-delivered lifestyle intervention. Preliminary (unpublished) findings indicate that participants who received the extended contact intervention had significantly better weight loss and behavioural outcomes at 12-months (Fjeldsoe, 2014). Overall, there is limited experimental evidence to date supporting the use of text messaging to promote the maintenance of longer-term weight loss and behaviour change, and even less is known about the theoretical constructs and related strategies to target during an extended contact intervention to support maintenance of behaviour change.

2.5 Theoretical constructs and intervention strategies common to successful maintenance outcomes

2.5.1 Theoretical constructs associated with maintenance of physical activity and dietary behaviour change

Health behaviour theories (e.g., Health Belief Model, Social Cognitive Theory) are commonly used to guide the development of intervention content. Numerous studies have

found that common constructs proposed in these theories, such as individual, social, and environmental constructs, predict short-term physical activity (Anderson et al., 2006; Rhodes et al., 2010; Rhodes et al., 2014; Sherwood et al., 2000; Trost et al., 2002; Wendel-Vos et al., 2007) and dietary behaviour change (Kremers et al., 2006; Rothman et al., 2009). Social Cognitive Theory has been particularly common in the development of physical activity interventions for breast cancer survivors (Rogers et al., 2004; Short et al., 2014). The underlying constructs of Social Cognitive Theory include: behavioural capability, outcome expectancy, self-efficacy, observational learning, reinforcements, and perceived environmental opportunity (Bandura, 1986). However, there is little consensus on how the underlying theoretical mechanisms of short-term behaviour change may relate to long-term behaviour change.

Maintenance of behaviour change has commonly been conceptualised to be governed by the same theoretical constructs that facilitate initiation (Rothman, 2000). However, this perspective is at odds with the frequent finding that many who successfully initiate behaviour change are unable to maintain that pattern of behaviour long-term (Rothman, 2000). Rothman and colleagues propose a theoretical framework that articulates the differences between initiation and maintenance of behaviour change, specifically applied to dietary behaviours (Rothman et al., 2009). A key factor in the framework is that decisions regarding behavioural initiation are based on expectations about future outcomes (i.e., outcome expectancy), whereas decisions regarding behavioural maintenance are based on the constant re-assessment of experiences caused by the new behaviour and whether they are sufficiently satisfying to warrant continued action (i.e., perceived satisfaction with outcomes; Rothman et al., 2009). Confidence in one's ability to perform the behaviour (i.e., self-efficacy) is also proposed to be more important for initiation than for maintenance of behaviour change (Rothman et al., 2009). While there is intuitive appeal for this framework, few studies have experimentally explored the importance of a range of constructs important for either short- or long-term behaviour change (Van Stralen et al., 2010; Williams et al., 2008). Early findings indicate potential differences in the constructs important for different phases of behaviour change (Williams et al., 2008) and provide preliminary support for Rothman's framework, but overall this area of research is lacking.

The broader evidence on the importance of constructs for short- and long-term behaviour change comes from studies in the general and breast-cancer specific population exploring predictors of short- and long- physical activity and dietary behaviour change, the broader weight loss and weight maintenance literature, and from descriptive studies of people who have maintained healthy behaviours. A review of these studies and findings related to the influence of these constructs on short- and long-term behaviour change are detailed in Appendix 2.A. A review of this evidence suggests the constructs most commonly reported to be important for short- and/or long-term physical activity and/or dietary behaviour change include: self-regulation, outcome expectancy, satisfaction with outcomes, self-efficacy, social support, perceived environmental opportunity, and enjoyment (physical activity only). Definitions of these seven constructs are also provided in Appendix 2.A. Overall, these studies suggest outcome expectancy is important for short-term change, and satisfaction with outcomes is important for long-term change. However, the importance of other constructs in predicting short- and long-term behaviour change is mixed. In summary, these studies provide initial support for Rothman's (2009) theoretical framework proposing different constructs may be important for targeting short- and long-term behaviour change, but overall the evidence to date is limited, mixed, and inconclusive. Recommendations for future research indicate exploring the theoretical constructs associated with long-term change will greatly contribute to understanding how to improve the design of interventions to better promote the maintenance of outcomes (Michie & Prestwich, 2010; van Stralen et al., 2009; Lawler et al., 2014).

2.5.2 Intervention strategies targeting weight loss maintenance

There is established evidence on the behavioural skills required for long-term weight loss maintenance (Funk et al., 2008; Jeffery et al., 2000; Thomas et al., 2014; Wadden et al., 2004; Wadden et al., 2005; Wing et al., 2005). The National Weight Control Registry (NWCR) was established in 1994, and is the largest (over 10,000 individuals) prospective investigation of long-term weight loss maintenance (National Weight Control Registry, 2011). Annual surveys are used to examine the behavioural and psychological characteristics of weight loss maintainers, and the strategies these individuals use to maintain weight loss (National Weight Control Registry, 2011). Findings from an analysis of the NWCR data found six key strategies are related to weight loss maintenance (Wing et al., 2005):

1. Engaging in high levels of physical activity (at least 60 minutes of moderate to vigorous physical activity per day)
2. Eating a low-calorie, low-fat diet (average of 5775 kJ per day)
3. Eating breakfast daily
4. Maintaining a consistent eating pattern across the week
5. Self-monitoring of weight on a regular basis (at least once per week)
6. Catching 'slips' before they turn into larger regains

The first four strategies listed above inform specific behavioural targets that should be promoted for maintenance of weight loss (e.g., eating breakfast daily). The last two strategies of self-monitoring and catching 'slips' (i.e., relapse prevention) belong to a larger group of strategies, often referred to as 'self-regulation' strategies. Self-regulation strategies include self-monitoring, goal setting, planning, self-reward, problem solving, and relapse prevention; all of which have been shown in other studies to be important in weight loss maintenance (Burke et al., 2011; Butryn et al., 2007; Elfhag et al., 2005; Thomas et al., 2014; Wing et al., 2001). Not only has self-monitoring of weight been shown to be important for weight loss maintenance (as evidenced above), but self-monitoring of physical activity and dietary intake has also been associated with successful weight loss maintenance (Befort et al., 2008; Byrne et al., 2003; Kruger et al., 2006; Vanderwood et al., 2011; Wadden et al., 2004; Wing et al., 2001; Wing et al., 2005). Self-monitoring is thought to impact on maintenance of behaviours because it requires individuals to pay attention to their actions, the conditions under which they occur, and their immediate and long-term effects (Bandura, 1998; Burke et al., 2009). The ability to set and consistently re-evaluate goals related to physical activity and diet, make and follow through with plans to meet these goals, and self-reward for goal attainment has been reported to be associated with successful weight loss maintenance (Befort et al., 2008; Kruger et al., 2006; Perri et al., 2009). The ability to solve problems, overcome barriers, and identify and correct small slips in physical activity and dietary behaviour to prevent small weight regains has also been significantly associated with long-term weight loss maintenance (Perri et al., 2001; Vanderwood et al., 2011). Overall, there is strong evidence suggesting that self-regulation skills for weight and physical activity and dietary behaviours are all important for weight loss maintenance.

The importance of the collection of strategies discussed above to weight loss maintenance is supported by the broader descriptive literature (Befort et al., 2008; Elfahg et al., 2005; Gorin et al., 2004; Kayman et al., 1990; Klem et al., 1997; Kruger et al., 2006; McGuire et al., 1999; Turk et al., 2009; Vanderwood et al., 2011; Wadden et al., 2004; Westenhoefer et al., 2004; Wing et al., 2001; Wyatt et al., 2002). Two randomised controlled trials have experimentally investigated whether manipulating the content of an extended contact intervention to focus on strategies related to satisfaction with weight loss outcomes (Jeffery et al., 2006) or motivation for weight loss (West et al., 2011) influenced weight loss maintenance. Both studies reported no differences in weight between groups receiving different content in the extended contact interventions. This evidence suggests that while there is an abundance of descriptive evidence on strategies important for weight loss maintenance, there is a lack of experimental evidence to suggest the intervention strategies that are associated with successful weight loss maintenance, although literature supports the need for on-going use of self-regulation skills.

2.6 Summary of literature review

Maintenance of physical activity and dietary behaviour change and weight loss maintenance is particularly important for long-term health outcomes among breast cancer survivors. However, there is minimal evidence regarding maintenance of behaviour change in this target group, or in the broader literature on the general adult population. Early research has identified the success of extended contact following the end of an initial behaviour change intervention in further supporting the maintenance of behaviour change. In the literature to date, these contacts have been conducted primarily via face-to-face or over the telephone, both of which can be costly and timely when delivered over extended time periods. Text messaging has been shown to be an efficacious mode of delivery in initial behaviour change interventions, and has been proposed to be an ideal modality to deliver cost-effective extended contacts necessary to achieve maintenance. There is emerging support for the acceptability and feasibility for text message-delivered extended contact interventions to promote the maintenance of weight loss and behaviour change, but the effectiveness of these interventions has not yet been established. Little is also known about the theoretical constructs and intervention strategies important for maintenance of physical activity and diet, but some guidance can be offered by the more extensive weight loss evidence base which indicates the importance of ongoing self-regulation skills.

2.7 Research plan

Aims and objectives

The overall aim of this thesis research was to understand and influence the maintenance of physical activity and dietary behaviour change in breast cancer survivors.

This aim was achieved through four objectives:

Objective 1: To conduct a systematic review of physical activity and/or dietary behaviour change interventions in breast cancer survivors to: (a) determine the frequency with which maintenance of behaviour change outcomes are reported; and, (b) determine the intervention strategies that are common in studies supporting maintenance of behaviour change in this population.

Objective 2: To conduct a pilot study to inform the development of a text messaging intervention to promote maintenance of physical activity and dietary change in breast cancer survivors.

Objective 3: To evaluate the efficacy, feasibility, and acceptability of a text message-delivered extended contact intervention, following the Living Well after Breast Cancer feasibility trial, to promote maintenance of physical activity and dietary behaviour change.

Objective 4: To evaluate the theoretical constructs and participant characteristics associated with short- and long-term physical activity and dietary behaviour change in participants who completed the Living Well after Breast Cancer extended contact intervention.

CHAPTER 3

PHYSICAL ACTIVITY AND/OR DIETARY BEHAVIOUR CHANGE INTERVENTIONS IN BREAST CANCER SURVIVORS: A SYSTEMATIC REVIEW OF THE MAINTENANCE OF OUTCOMES

3.1 Introduction

3.1.1 Context

There is a large evidence base of randomised controlled trials supporting the efficacy of physical activity interventions producing short-term (end-of-intervention) behaviour change in breast cancer survivors (Kim et al., 2013; Schmitz et al., 2005; Speck et al., 2010).

These reviews indicate a need to further investigate whether changes in behaviour can be maintained post-intervention (Kim et al., 2013; Schmitz et al., 2005; Speck et al., 2010).

There is a less-developed evidence base supporting the efficacy of dietary (Chlebowski et al., 2006; Pierce et al., 2007a) or physical activity and dietary interventions (Morey et al., 2009) in breast cancer survivors, with limited support for maintenance of dietary behaviour change. No review has systematically explored the evidence base on maintenance of physical activity and dietary outcomes following an initial behaviour change intervention in breast cancer survivors. Weight outcomes were not addressed in this systematic review due to the fact few studies reported on randomised trials of weight loss interventions in breast cancer survivors, and none reported maintenance outcomes.

3.1.2 Objective

The objective of this study was to conduct a systematic review of the physical activity and dietary intervention literature in breast cancer survivors to determine:

1. What proportion of studies report maintenance outcomes following an initial physical activity and/or behaviour change intervention in breast cancer survivors?
2. How successful are physical activity and/or dietary interventions for breast cancer survivors in promoting maintenance of behaviour change?

3. What sample, intervention, and methodological characteristics are common among trials that report successful maintenance of physical activity and/or dietary behaviour change in breast cancer survivors?
4. Which intervention strategies are common among trials that report successful maintenance of physical activity and/or dietary behaviour change in breast cancer survivors?

The results of this systematic review were published in *Journal of Cancer Survivorship* in 2013. Below is a copy of the manuscript. Supplementary materials published as part of this manuscript are available in Appendix 3.A and 3.B.

3.2 Physical activity and/or dietary interventions in breast cancer survivors: A systematic review of the maintenance of outcomes

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Physical activity and/or dietary interventions in breast cancer survivors: a systematic review of the maintenance of outcomes

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Abstract

Purpose Maintaining physical activity and dietary improvements achieved during an intervention is important for the long-term health outcomes of breast cancer survivors. This review aimed to determine: (a) the proportion of physical activity and/or dietary intervention trials in breast cancer survivors that assessed post-intervention maintenance of outcomes, (b) the proportion of trials that achieved successful post-intervention maintenance of outcomes, and (c) the sample, intervention, and methodological characteristics common among trials that achieved successful post-intervention maintenance of outcomes.

Methods A structured search of PubMed, CINAHL, Medline via Ovid, Web of Science, CENTRAL, and PsycInfo was conducted for articles published until March 2012. Included trials had to evaluate a randomized controlled trial of a physical activity and/or dietary behavior change intervention that targeted breast cancer survivors and report on between-group differences of behavioral outcomes at end-of-intervention and at least 3 months post-intervention follow-up. Methodological quality of included trials was also assessed.

Results The search resulted in 1,298 publications. Of 63 identified trials that assessed end-of-intervention outcomes, 10 (16 %) assessed post-intervention maintenance of outcomes; four of these 10 trials achieved successful maintenance. Due to the limited number and heterogeneity of the

four trials, few commonalities in sample, intervention, and methodological characteristics were identified.

Conclusion Assessing post-intervention maintenance of physical activity and dietary outcomes in breast cancer survivors is rare. There is a pressing need to direct more attention to this issue to inform the development of interventions to improve the long-term health outcomes for the growing number of breast cancer survivors.

Implications for cancer survivors For breast cancer survivors, maintaining regular physical activity and a healthy diet are important to enhancing health and well-being over the long-term. More research is needed to identify the best ways of supporting survivors to make and maintain these lifestyle changes.

Keywords Lifestyle interventions · Randomized controlled trials

Introduction

Breast cancer survivors are at increased risk for cancer recurrence and mortality, as well as developing lifestyle-related chronic conditions such as cardiovascular disease and diabetes [1–3]. Engaging in healthful behaviors, in particular, regular physical activity and eating a healthy diet, is important for reducing risk of such adverse outcomes [4–7]. Cancer organizations around the world recommend cancer survivors engage in regular physical activity at a moderate intensity for at least 150 min/week; eat a healthy diet that is high in vegetables, fruits, and whole grains; and achieve and maintain a healthy body weight [8, 9]. However, the majority of breast cancer survivors fail to meet these guidelines [10–12].

In breast cancer, there is a large evidence base of randomized controlled trials supporting the efficacy of physical activity interventions in producing short-term (end-of-

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intervention) behavior change [13, 14] and a less-developed but similarly encouraging evidence base supporting the efficacy of dietary interventions [15–17]. Following initial improvements in physical activity and diet, it is important that these healthy lifestyle behaviors are maintained over time to achieve significant long-term health benefits [18]. However, there is much less empirical evidence examining the maintenance of behavior change outcomes [19]—defined here as outcomes assessed at least 3 months following the end-of-intervention (i.e., post-intervention follow-up). A previous review on the translation of physical activity interventions in breast cancer found very few trials assessed post-intervention maintenance of outcomes (four of 25 trials, 16 %) [20]. The present review extends these findings by including intervention trials targeting physical activity and/or diet and by documenting the success of trials in achieving successful maintenance of outcomes.

The aim of this paper is to systematically review the evidence on maintenance of physical activity and dietary outcomes following behavior change interventions in breast cancer survivors. Specifically, this review will determine: (a) what proportion of trials assess post-intervention maintenance of outcomes following an initial physical activity and/or dietary behavior change intervention in breast cancer survivors, (b) what proportion of these trials achieve successful post-intervention maintenance of behavioral outcomes, and (c) what sample, intervention, and methodological characteristics are common among trials that achieve successful post-intervention maintenance of outcomes compared to those that do not.

Methods

Search strategy

A structured search of PubMed, CINAHL, Medline via Ovid, Web of Science, CENTRAL, and PsycInfo was conducted for articles published until March 2012. For physical activity trials, title or abstract was searched for the terms: breast AND (cancer OR neoplasm OR carcinoma OR malignan*) AND (intervention OR program* OR trial) AND (RCT OR random* OR control*) AND (physical activit* OR exercis* OR strength OR aerobic OR resistance). For diet trials, title or abstract was searched for the terms: breast AND (cancer OR neoplasm OR carcinoma OR malignan*) AND (intervention OR program* OR trial) AND (RCT OR random* OR control*) AND (diet* OR nutrition). Where possible, the search was limited to “humans,” “adults,” and “English language.”

Trial inclusion criteria

Inclusion criteria were applied hierarchically in the order below and included trials that (a) assessed a behavioral

intervention that targeted physical activity and/or dietary behavior change in adults (interventions focused solely on upper-body exercises for lymphedema were excluded), (b) targeted women with breast cancer (either undergoing or having completed treatment; may have also targeted patients with other types of cancer), (c) randomized participants to an intervention and a control or comparison group, (d) reported on statistical significance between groups for a physical activity and/or dietary outcome at end-of-intervention, and (e) reported on statistical significance between groups at least 3 months following the end-of-intervention (with no intervention contact between end-of-intervention and post-intervention follow-up). For trials with mixed cancer populations, outcomes did not need to be reported separately for breast versus non-breast cancer participants, given mixed population trials would significantly contribute to the scope and inclusiveness of the body of evidence under review. These inclusion criteria were assessed based on abstract alone if possible or full-text if further clarification was needed. Two researchers independently assessed abstracts and full-text publications, and discrepancies were discussed and verified.

Data extraction

Data extracted from eligible trials included sample characteristics (e.g., sample size, proportion of participants with breast cancer, mean age of participants, mean baseline BMI), clinical and treatment characteristics [e.g., time since diagnosis, cancer stage, stage of treatment (during or after treatment), time since treatment], intervention characteristics (e.g., theoretical basis, duration, frequency and mode of contact, delivery context, length of post-intervention follow-up, comparison group type), intervention strategies (e.g., number and type of behavior change strategies), trial methodology (e.g., retention rates, behavioral measurement tools), and intervention outcomes [e.g., group descriptive statistics, statistical significance of between-group differences (*p* values)]. The behavior change strategy taxonomy originally developed by Abraham and Michie [21] and recently revised [22] was used by two investigators to independently code behavior change strategies described in each trial. The taxonomy is an inventory of 40 descriptive, theory-based strategies used to facilitate behavior change (e.g., goal setting, self-monitoring, barrier identification). The reporting of specific strategies to target maintenance was also noted; this included strategies from the taxonomy (i.e., use of follow-up prompts; relapse prevention/coping planning) as well as others noted by the trial authors.

Defining successful maintenance of behavior change outcomes

A trial was considered to achieve successful maintenance of outcomes if a statistically significant between-group

difference in favor of the intervention group was reported at end-of-intervention and after a minimum 3-month post-intervention follow-up period, for at least 50 % of the behavior change outcomes assessed. This definition has been used in a previous review of physical activity and dietary behavior change interventions [23]. Where both physical activity and dietary behaviors were assessed in the same trial, this criterion was applied both separately and collectively for physical activity and dietary outcomes. A 6-month duration has been reported to be the optimal minimum post-intervention follow-up period to assess maintenance of outcomes [20, 24]; however, this review used the more lenient definition of a minimum 3-month post-intervention follow-up period, as guided by that used in another review [25], and to be more inclusive given that this is the first review of post-intervention maintenance of behavior change outcomes in breast cancer survivors.

Methodological quality

A methodological quality score (0–10), derived from the CONSORT statement for randomized controlled trials [26] and previously used quality criteria for methodology and reporting [27], was calculated. Design or methodological publications for the reviewed trials were used to assist in calculating quality scores (where available). One point was awarded for each criterion met, which included (1) adequate description of randomization and concealment process (i.e., describes sequence generation and allocation concealment), (2) baseline demographic and clinical characteristics reported separately for each group (including baseline values of behavioral outcomes), (3) acceptable participant attrition (≤ 20 % for ≤ 6 months post-baseline; ≤ 30 % for > 6 months post-baseline), (4) assessor blinding, (5) behavior assessed at ≥ 6 months post-intervention follow-up period (a 6-month duration has been used here as it has been reported as the higher-quality criterion for assessing post-intervention maintenance of outcomes [20, 24]), (6) intention-to-treat analyses and an appropriate approach to missing data, (7) potential confounders including baseline level of behavior appropriately accounted for in analyses, (8) power calculation reported and trial adequately powered for at least the primary outcome, (9) use of validated behavioral measurements tools, and (10) summary results presented with estimated effect size (between-group difference) and precision estimates. Two researchers independently assessed trials and discrepancies were discussed and verified.

Data analysis

Due to the small number of trials included in this review, statistical comparisons between trials were not performed. Common sample, intervention, and methodological

characteristics are presented descriptively and compared between trials that achieved maintenance and those that did not. For trials that included more than two comparison groups [28–30], outcomes were compared for differences between the least and most intensive intervention groups.

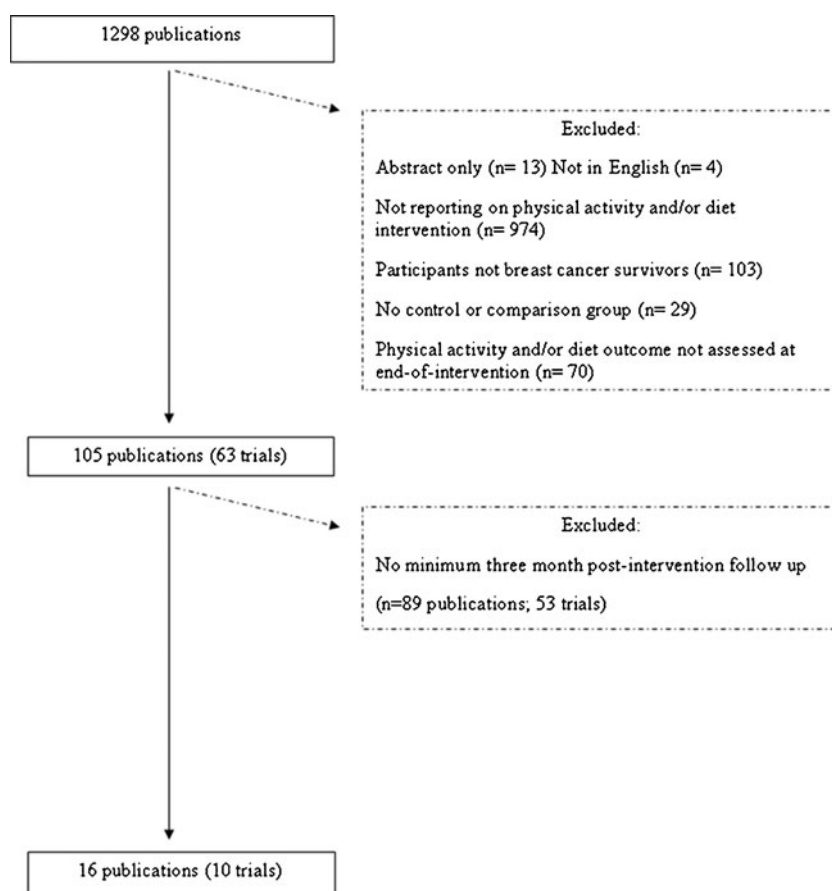
Results

The database search yielded a total of 1,298 publications. Of these, 63 trials (105 publications) were randomized controlled trials of physical activity and/or dietary interventions in breast cancer assessing end-of-intervention outcomes (see Fig. 1). A search for the first author and trial name was conducted in the databases to ensure further publications from the trials reporting end-of-intervention outcomes were not missed in the original search. This search identified two additional publications.

Trials assessing post-intervention maintenance of outcomes

Of the 63 trials reporting on end-of-intervention outcomes, 10 (16 %) trials assessed post-intervention maintenance of outcomes [29–35]; of these, seven trials evaluated a physical activity intervention, one evaluated a dietary intervention [28], and two evaluated a combined physical activity and dietary intervention [36, 37] (see Table 1; full details of included trials are available in Online Resource 1). Primary outcomes of the trials included behavioral outcomes (i.e., physical activity and/or diet [28, 30, 34–36]) and clinical outcomes (i.e., functional status [37], cancer-related fatigue [31, 32], and quality of life [29, 33]). Most trials reported on multiple outcomes for physical activity and/or dietary behaviors. Physical activity outcomes included aerobic fitness [29, 31, 32, 35], strength [31, 32, 35], duration and intensity of physical activity (e.g., moderate–vigorous physical activity minutes per week) [30, 33–36], and total energy expenditure (e.g., kilocalories per week) [34, 37]. All three trials assessing dietary intake used multiple dietary indicators, including fat and saturated fat intake, fruit and vegetable intake, and diet quality [28, 36, 37], and one trial also measured total energy intake [28].

Seven of the 10 trials included women with breast cancer exclusively [28–31, 33–35], and two trials targeted participants during treatment [32, 33]. Most trials (seven of 10) had an initial intervention duration of between 1 to 4 months [28–33, 35], with the remaining trials delivering interventions of 6 months or longer (three of 10; range 6 to 10 months) [34, 36, 37]. Post-intervention follow-up periods spanned 3 to 4 months (five of 10) [29, 31, 32, 34, 35], or 6 months or longer (five of 10; range 6–12 months) [28, 30, 33, 36, 37]. Most trials used a combination of intervention delivery modalities. The primary delivery modality in the

Fig. 1 Reasons for exclusion of publications from database search**Table 1** Summary of trials included in review ($n=10$)

First author, year	Country	Target behavior	<i>n</i>	Sample	Duration of intervention	Post-Ix follow-up (months)	Quality score (<i>n</i> /10)	Successful maintenance?
Cantarero-Villanueva, 2012 [31]	Spain	PA	78	Breast cancer survivors post-treatment	6 weeks	4	4	Yes
Daley, 2007 [29, 48]	UK	PA	72	Breast cancer survivors post-treatment	2 months	4	6	No
Demark-Wahnefried, 2006 [37, 49]; Clutter Snyder 2007 [50]	USA	PA + D	182	Breast (57 %) and prostate (43 %) cancer survivors post-treatment	6 months	6	6	No
Demark-Wahnefried, 2007 [36, 51]; Ottenbacher, 2012 [52]; Christy, 2011 [53]	USA	PA + D	543	Breast (59 %) and prostate (41 %) cancer survivors post-treatment	10 months	12	6	Yes
Hebert, 2001 [28]	USA	D	106	Breast cancer survivors post-treatment	4 months	8	7	No
Mustian, 2009 [32]	USA	PA	38	Breast (71 %) and prostate (29 %) cancer survivors undergoing treatment	1 month	3	5	Yes
Mutrie, 2007 [33]	Scotland	PA	201	Breast cancer survivors undergoing treatment	3 months	6	9	Yes
Pinto, 2005, 2008 [34, 54]	USA	PA	86	Breast cancer survivors post-treatment	6 months	3	6	No
Rogers, 2009 [35, 55]	USA	PA	41	Breast cancer survivors post-treatment	3 months	3	6	No
Vallance, 2007 [30, 56, 57]	Canada	PA	189	Breast cancer survivors post-treatment	3 months	6	6	No

PA physical activity, D diet, PA + D physical activity and diet, Post-Ix post-intervention

majority of the trials was face-to-face contact (six of 10) [28, 29, 31–33, 35], with some primarily using print (two of 10) [30, 36] or telephone counseling (two of 10) [34, 37]. Trials achieved a median methodological quality score of 6 out of 10 (see Table 1; full details of quality scores are available as Online Resource 2).

Trials achieving successful post-intervention maintenance of outcomes

Of the 10 trials that assessed post-intervention maintenance of outcomes, four trials (40 %) achieved successful maintenance of behavior change for at least 50 % of outcomes; three of these trials assessed a physical activity intervention [31–33], and one trial assessed a combined physical activity and dietary intervention (only diet behavior successfully maintained) [36].

This review intended to statistically evaluate differences in sample, intervention, and methodological characteristics between trials that achieved successful post-intervention maintenance outcomes compared to those that did not; however, the small number of trials precluded this. Instead, findings are reported descriptively, and differences are interpreted with caution. Comparisons between trials achieving successful and unsuccessful post-intervention maintenance outcomes are detailed in Table 2. Comparing the four trials that achieved successful maintenance and the six that did not, successful maintenance appeared to be more common among trials that targeted participants who were undergoing treatment for breast cancer versus taking part in the intervention post-treatment (two of four vs. zero of six trials) and, in conjunction, who were closer to diagnosis at the point of trial participation (median 4.6 vs. 11.1 months). Trials achieving successful maintenance were less likely to target breast cancer survivors exclusively compared to unsuccessful trials (two of four vs. five of six). There was no meaningful difference in the age (median 54.3 vs. 53.2 years) or BMI (median 27.4 vs. 27.7 kg/m²) of participants in the trials that achieved successful maintenance compared to those that did not achieve successful maintenance.

All of the six trials not achieving successful maintenance reported using a theoretical model for intervention development, compared to only two of the four trials that achieved maintenance of outcomes. The theoretical models used in studies reporting successful maintenance included the transtheoretical model [33] and a combination of the transtheoretical model and social cognitive theory [36]. However, these models were also used in trials that reported unsuccessful maintenance outcomes (full details are available in Online Resource 1). In conjunction, trials achieving successful maintenance reported using half the number of behavior change strategies compared to those that reported

unsuccessful maintenance (median 5 vs. 11 strategies). Among the 10 trials assessing maintenance of outcomes, four described specific strategies to promote maintenance [29, 31, 33, 34], with two of these achieving successful post-intervention maintenance of outcomes [31, 33]. Despite the same methodological quality scores between successful and unsuccessful maintenance trials (median 6 vs. 6), successful maintenance trials were more likely to inadequately report on methods of dealing with missing data (3/4 vs. 2/6) [31, 33, 36]. The primary intervention outcome was more likely to be a clinical outcome in trials achieving successful maintenance compared to those reporting unsuccessful maintenance (3/4 vs. 2/6).

Comparing the trials that reported successful maintenance and those that did not, there were few differences in: intervention duration (median 2.5 vs. 3.5 months), length of post-intervention follow-up period (median 5 vs. 5 months), retention rate from baseline to post-intervention follow-up (median 90 vs. 91 %), use of face-to-face contact as the primary delivery modality (3/4 vs. 3/6), home-based intervention delivery context (2/4 vs. 3/6), or trials having minimum weekly intervention delivery contacts (2/4 vs. 4/6).

Discussion

This is the first review to systematically evaluate post-intervention maintenance of physical activity and dietary behavior change outcomes in breast cancer survivors. Findings indicate a paucity of evidence, with less than one fifth of trials assessing the maintenance of outcomes at least 3 months following the end-of-intervention. This lack of reporting on the maintenance of behavior change is similar to findings from other reviews which found that maintenance of outcomes were reported in 16 % of physical activity only intervention trials in breast cancer [20], 18 % of physical activity and dietary intervention trials in the general adult population [25], and 20 % of physical activity trials in the obese adult population [38].

This review found that when post-intervention maintenance is assessed, less than half of physical activity and/or dietary intervention trials achieve successful maintenance. This maintenance success rate is smaller than the 72 % reported for physical activity and dietary intervention trials conducted in the general adult population [25]. However, the application of a more stringent criterion to define successful maintenance in this review, compared to the less stringent criterion used by Fjeldsoe and colleagues [25] (maintenance of at least 50 % of outcomes vs. maintenance of at least one behavioral outcome, respectively), strongly influences this difference. This issue highlights a key difficulty in evaluating maintenance of outcomes in intervention trials, given the ambiguity in the field regarding the amount

Table 2 Summary of differences between trials achieving successful and unsuccessful maintenance ($n=10$)

	Successful maintenance ($n=4$) <i>n</i>	Unsuccessful maintenance ($n=6$) <i>n</i>
Intervention target		
Physical activity only	3	4
Diet only	0	1
Combined physical activity and diet	1	1
Primary intervention outcome		
Behavioral	1	4
Clinical	3	2
Sample characteristics		
Exclusively targeted breast cancer survivors	2	5
Sample size, median (range)	140 (38, 543)	107 (41, 377)
Age in years, median (range)	54.3 (49.0, 60.0)	53.2 (50.0, 71.5)
BMI, median kg/m ² (range)	27.4 (27.3, 30.0)	27.7 (27.3, 30.9)
Treatment characteristics		
Time since diagnosis, median months (range)	4.6 (3.8, 5.4)	11.1 (1.7, 39.0)
Cancer stage (0–III; I–IIIA)	2; 1	1; 3
Intervention conducted during treatment	2	0
Intervention characteristics		
Application of theoretical model of behavior change to intervention development	2	6
Intervention duration, median months (range)	2.5 (1.0, 10.0)	3.5 (2.0, 6.0)
Intervention contact at least once per week	2	4
Primary delivery modality (face-to-face; telephone; print)	3; 0; 1	3; 2; 1
Home-based delivery context	2	3
Post-intervention follow-up duration, median months (range)	5 (3, 12)	5 (3, 8)
Retention rate from baseline to post-intervention follow-up, median % (range)	90 (83, 100)	91 (72, 98)
Usual care comparison group	2	2
Intervention strategies		
Number of behavior changes strategies, median (range)	5 (3, 10)	11 (4, 15)
Use of specific maintenance strategies	2	2
Methodological quality		
Adequate description of randomization and concealment process	4	3
Baseline demographic and clinical characteristics reported separately for each group	4	6
Acceptable attrition (≤ 20 % for ≤ 6 months post-baseline; ≤ 30 % for > 6 months post-baseline)	3	5
Assessor blinding	1	0
Behavior assessed at ≥ 6 months post-intervention follow-up period	2	3
Intention-to-treat analyses and an appropriate approach to missing data	1	4
Potential confounders including baseline level of behavior appropriately accounted for in analyses	3	4
Power calculation reported and trial adequately powered for at least the primary outcome	1	3
Use of validated behavioral measurements tools	3	6
Summary results presented with between-group difference and precision estimates	2	3

n varies depending on information reported by authors

and duration of behavior change required to define successful post-intervention maintenance [39]. The issue of how best to define successful maintenance in interventions with both single and multiple outcomes also warrants further attention.

Due to the small and heterogeneous sample of trials included in this review, it was difficult to identify sample, intervention, and methodological characteristics common among trials achieving successful maintenance of outcomes, compared to those that did not. Trials achieving maintenance were more likely to include inadequate reporting of methods for dealing with missing data at post-intervention follow-up, which may have contributed to an inflated maintenance effect. With these caveats in mind, caution in the interpretation of findings is advised.

Findings suggest successful maintenance was more common in trials that: targeted participants undergoing treatment (and were closer to diagnosis), although there were only two such trials; relied less heavily on a theoretical model for intervention development; and used fewer behavioral intervention strategies. Successful maintenance trials were also more likely to evaluate clinical (e.g., fatigue, quality of life) rather than behavioral (e.g., physical activity, dietary) primary outcomes. Those focusing on clinical primary outcomes were also less likely to be guided by behavior change theories or report the use of behavior change strategies. One interpretation may be that targeting women closer to diagnosis, which has been previously described as a teachable moment [12], facilitates higher motivation to make and maintain lifestyle changes. However, it has also been suggested that intervention effects may be more robust when targeted to participants post-treatment compared to during treatment, given participants may be better able to respond physically and mentally following completion of treatment [40]. Given the small number of trials in this review and with conflicting suggestions from the broader literature, randomized controlled trials are needed to better inform the impact on maintenance of outcomes of interventions delivered during versus after breast cancer treatment [40].

The majority of trials included in this review targeted physical activity only, perhaps reflecting the stronger evidence for the benefits of physical activity for improving the outcomes of breast cancer [13, 14, 41, 42], including survival [4, 7], compared to diet [43]. However, two landmark dietary trials [15, 16] were not included in this review because they did not assess post-intervention maintenance of outcomes following their 5- [15] and 7-year [16] interventions. These trials suggest that extending program contact with participants may promote the longevity of initial behavior change [16, 44]. Further research is required to determine the effects that specific maintenance strategies, including follow-up prompts and tapered or ongoing contact, have on the maintenance of behavior change in the

breast cancer population [20, 25]. It is also important for trials to clearly identify, operationalize, and report intervention content [45], something that was done poorly by most trials in this review.

Two papers not included in this review due to trial design [19] and more recent publication [46] contribute significant additional considerations to this topic. The RENEW trial conducted by Demark-Wahnefried and colleagues [19] used a wait-list control, cross-over design to evaluate a 12-month tailored print- and telephone-delivered intervention targeting breast, prostate, and colorectal cancer survivors (at least 5 years post-diagnosis). The cross-over design meant comparisons between an intervention and no-contact control group were not possible at 12 months post-intervention follow-up. However, findings suggest that physical activity and dietary outcomes for the wait-list control group at end-of-intervention (12 months) and intervention group at 12 months post-intervention follow-up (24 months) were comparable in magnitude, thus suggesting end-of-intervention effects could be successfully maintained up to 12 months post-intervention. Following on from the 6-month post-intervention maintenance of outcomes included in this review [33], Mutrie and colleagues recently published 5-year post-intervention outcomes [46]. Maintenance of self-reported physical activity was successfully achieved from end-of-intervention to the 5-year post-intervention follow-up [46]. Together, these two trials indicate that assessing the maintenance of outcomes is slowly starting to receive more attention in trials evaluating health behavior change interventions among cancer survivors. Furthermore, they provide emerging support for the ability of such interventions to produce long-lasting effects for breast cancer survivors.

In summary, this review has found a very limited evidence base from which to inform how best to sustain the initial improvements in physical activity and dietary change seen in most intervention trials in breast cancer. There is thus a pressing need to include post-intervention assessments to: (1) determine the intervention characteristics that are effective in promoting the post-intervention maintenance of behavior change [18, 19, 24], (2) inform the translation of lifestyle interventions for breast cancer survivors into practice [20, 24], and (3) promote the long-term health and well-being of breast cancer survivors [19]. In the clinical setting, survivorship care plans provide an excellent opportunity to promote the initiation and maintenance of healthy lifestyle behaviors [47]. Assessment of the outcomes of survivorship care plans will provide an opportunity to evaluate the longer-term success of interventions to promote maintenance of health behavior change. The adoption of healthy lifestyle behaviors is important following breast cancer diagnosis [7]; however, it is the maintenance of these behaviors that is critical to the long-term health and survival of women with breast cancer [4].

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Conflict of interest The authors declare they have no conflict of interest.

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3.3 Summary

This systematic review was the first to evaluate the extent to which physical activity and dietary behaviour change intervention trials in breast cancer survivors reported on maintenance of outcomes post-intervention, and the intervention characteristics and strategies associated with successful maintenance of behaviour change. Few trials reported on maintenance outcomes following the end of an intervention, and a small proportion reported successful maintenance. Due to the small and heterogeneous sample of trials identified in this review, it was difficult to identify intervention characteristics common to maintenance. Increased efforts are needed to determine the key intervention characteristics associated with successful maintenance of behaviour change to promote long-term health and wellbeing in breast cancer survivors. In summary, this review identified a strong need to report on post-intervention outcomes to inform the future development of behaviour change interventions to promote the maintenance of behaviour change in the breast cancer survivor population.

CHAPTER 4

FEASIBILITY AND ACCEPTABILITY OF A PHYSICAL ACTIVITY AND DIETARY TEXT MESSAGE-DELIVERED INTERVENTION IN BREAST CANCER SURVIVORS: SMS-4-LIVING WELL PILOT STUDY

4.1 Introduction

4.1.1 Context

Evidence supports the efficacy of mobile phone text messaging as a broad-reach intervention delivery modality for promoting initial behaviour change (Fjeldsoe et al., 2010b; Johnston et al., 2014; Maddison et al., 2014; O'Reilly et al., 2013; Prestwich et al., 2010; Spring et al., 2012), and emerging evidence supports text message-delivered extended contact to promote the maintenance of weight loss (Donaldson et al., 2014; Gerber et al., 2009; Shaw et al., 2013). However, there has been some scepticism regarding the suitability of text message-delivered interventions in older adults (Greaney et al., 2012). Evidence indicates intervention success depends heavily on the ability to tailor and personalise intervention content to meet unique needs and preferences of individuals (Noar et al., 2007), and on the acceptability of the intervention delivery modality (Turk et al., 2009). Whilst there is emerging evidence to support the efficacy of text messaging in promoting behaviour change in older adults (Maddison et al., 2014), few studies have focused on evaluating the acceptability and tailoring preferences within this population group. In addition, little is known about the acceptability of using text messages to target physical activity and dietary behaviour change simultaneously (Norman et al., 2007; Spring et al., 2012). The primary aim of this pilot study was to explore the *acceptability* of sending tailored physical activity- and diet-related text messages to breast cancer survivors, a predominately older population. This study also sought to determine how *feasible* it was to develop and send highly personalised text messages promoting physical activity and dietary behaviour change to this target group.

4.1.2 Objective

This chapter addresses the second objective of the thesis: to conduct a pilot study to establish the *feasibility and acceptability* of sending physical activity- and diet-related text messages to breast cancer survivors. This pilot study did not specifically target the maintenance of behaviour change due to the logistical challenge of recruiting participants following an intervention. However, as outlined in existing 'mobile health' (mHealth) intervention development frameworks (i.e., text message frameworks), it was important to conduct this formative research to establish the acceptability of a text message delivery modality in this target group (Waterlander et al., 2014; Whittaker et al., 2012). This pilot study was called 'SMS for Living Well' (SMS-4-LW), and was conducted between March and June 2011. The findings from this study informed the development of the Living Well after Breast Cancer extended contact intervention (detailed in Chapter Five).

4.2 **Methods**

4.2.1 Study design

This was a qualitative feasibility study in which participants: i) completed a physical activity and diet goal setting telephone interview with the PhD candidate; ii) received individually tailored text messages for a period of two weeks (based on the information collected in the goal setting interview); and, iii) participated in a qualitative feedback interview. Ethical clearance for this study was obtained from The University of Queensland, School of Population Health Research Ethics Committee (#LS140211).

4.2.2 Recruitment

Participants were recruited through the Breast Cancer Network Australia (BCNA) Review and Survey group. Members of this network are breast cancer survivors who are interested in volunteering to participate in breast cancer-related research. Recruitment procedures followed BCNA research recruitment policies. The BCNA emailed a sample of Brisbane-based members a brief study description (Appendix 4.A). Members expressed their interest in participating via email to the PhD candidate who then contacted potential participants via telephone to screen for eligibility. To be eligible for participation, women had to:

- (1) have previously been diagnosed with breast cancer; and

- (2) have completed their primary treatment for their breast cancer (i.e., surgery, chemotherapy, radiation; this did not include hormone therapy or long-term treatment with Herceptin); and
- (3) not be currently restricted from participating in physical activity by poor health or a medical condition; and
- (4) be aged 18 to 75 years of age; and
- (5) currently reside within a 100 kilometre radius of Brisbane; and,
- (6) own a mobile phone

Eligible participants were posted a study information sheet (Appendix 4.B), a text message example sheet (Appendix 4.C), consent form (Appendix 4.D), and reply-paid envelope. Participants were asked to sign the consent form and return it in the reply paid envelope. In qualitative research, the sample size is determined when no new themes emerge from the data collection process (Stewart et al., 1990). Therefore, after each interview, the PhD candidate considered whether additional women needed to be recruited.

4.2.3 Delivery of pilot intervention

There were four different types of text messages that participants received that were aligned with evidence-based constructs suggested to be important for behaviour change (see Table 4.1). Self-regulation, identified as a key construct associated with successful weight loss and physical activity and dietary behaviour change was the key strategy promoted in this pilot intervention (see Chapter Two, Section 2.5.1 and Section 2.5.2). The primary function of each message was to therefore target a strategy that would improve self-regulation skills of participants (such as planning, self-monitoring, barrier identification and problem solving; Michie et al., 2011). In addition, message content was designed to target a range of other constructs proposed to be important for behaviour change, including outcome expectancy, self-efficacy, and social support (see Chapter Two, Section 2.5.1).

Table 4.1: Examples of the types of physical activity- and diet-related text messages, and the related constructs targeted within each message type

Message type	Constructs (and strategies) targeted	Physical activity example (Participant's Goal = to walk for 30mins four times per week)	Diet example (Participant's Goal = to eat 1 cup of salad or veggies with dinner every night)
1. Cue for planned behaviour	Outcome expectancy Self-regulation (planning, problem solving)	Deb its time 4 ur brisk 30min walk. Get back into an exercise routine - u will b rewarded with feeling & looking better. Lauren, SMS-4-LW	Its dinner time Deb. Dont forget 2 have a cup of veggies – a small change every day will add up 2 a big difference over time. Lauren, SMS-4-LW
2. Pre-determined barrier	Self-regulation (problem solving)	Deb if its raining this morning go 2 Cherside 2 walk around the shops. Its a great way 2 get reach ur goal 2 walk 4 x 30mins this week. Lauren, SMS-4-LW	If ur having takeaway tonight Deb remember ur healthy eating goal - add a side salad or some fresh steamed veggies. Lauren, SMS-4-LW
3. Tip	Self-efficacy Social support Self-regulation (problem solving, planning, self-monitoring)	Remind Leslie about ur plans 2 walk in the mornings Deb. Make the promise 2 support each other 2 get fitter. Lauren, SMS-4-LW	Deb remember 2 record what u have 4 dinner tonight in ur diary. Is it on the fridge? Lauren, SMS-4-LW
4. Goal check	Self-regulation (self-monitoring)	Deb did u reach ur exercise goal 2 walk 4 mornings this week for 30mins? Let me know. Lauren, SMS-4-LW	And how about ur eating goal Deb? Did u reach ur goal 2 eat 1 cup of salad or veggies with dinner each night this week? Lauren, SMS-4-LW
4A. Goal check reply	Self-efficacy Social support Outcome expectancy Self-regulation (self-reward, self-monitoring, planning)	<p>"Yes" response</p> <p>Well done Deb! Its hard 2 get back into a routine & u have made an excellent start. Keep it up 4 next week. Lauren, SMS-4-LW</p> <p>"No" response</p> <p>Dont worry Deb. Plan with Leslie the mornings u want 2 walk so ur less likely 2 let each other down. U can do it. Lauren, SMS-4-LW</p>	<p>"Yes" response</p> <p>Excellent Deb! I am sure ur enjoying feeling healthier. Remember 2 reward ur hard work with a pedicure. Well done. Lauren, SMS-4-LW</p> <p>"No" response</p> <p>Its OK Deb. I am sure u can do it this week. Use ur diary 2 track ur progress & give u motivation 2 achieve ur goal. Lauren, SMS-4-LW</p>

Participants completed a one-on-one goal setting telephone interview with the PhD candidate (approximately 30 minutes). This interview was guided by a script (Appendix 4.E) and discussed: participants' current exercise and eating habits; negotiation of a number of small realistic exercise and healthy eating goals for participants to reach over a two week period; and, participants' preferences for the timing, content, and frequency of text messages they would receive. The four different types of text messages were illustrated to participants in the text message example sheet (Appendix 4.C) to aid discussion during the goal setting interview. The information gathered in this interview was used to tailor the physical activity- and diet-related text messages for each participant. The wording of the text messages was tailored to participant's first name, weekly behavioural goals, outcome expectancies, barriers and solutions, and social support person's name (see Table 4.1 for examples).

While the frequency of text messages was tailored to participant preference, participants were instructed that they needed to receive at least one of each of the four types of messages for both physical activity and dietary behaviours over the two weeks (i.e., cue for planned behaviour; pre-determined barrier; tip; goal check). Thus, participants received a minimum of eight text messages over 14 days.

Participants were instructed that they did not need to reply to messages, except for the weekly goal check message, which explicitly requested a response from the participant (see 'goal check' message example in Table 4.1). If participants replied to the weekly goal check message, they received an additional message providing feedback based on whether they had reached their goal or not (see 'goal check reply' message in Table 4.1). All text messages were limited to 160 characters, and were generated and delivered manually by the PhD candidate using 'Optus EmailSMS', an off-the-shelf program that operates through Microsoft Outlook 2007. All words in the pilot text messages were spelt out in full except for common abbreviations (e.g., Be = b; You = u; To = 2; See = c; Your = ur; For = 4).

4.2.4 Evaluation of pilot intervention

Participants completed a one-on-one in-person or telephone (based on participant preference) feedback interview at the end of the two week text messaging period. This interview (approximately 30 minutes) was semi-structured and guided by a script (Appendix 4.F). The aim of this interview was to gather information about participants' experiences with receiving the text messages. More specifically, the interview addressed participants': likes and dislikes about the language, frequency, and timing of the messages; how the content of the messages impacted their behaviours; and, their suggestions for improving text message support for exercise and healthy eating in the context of these being delivered following the end of an initial weight loss intervention (i.e., similar to the context of the Living Well after Breast Cancer feasibility trial). The interview was audio recorded and then transcribed verbatim by the PhD candidate.

4.2.5 Data treatment

Given the nature of the qualitative interview data, thematic analysis followed a systematic and iterative process (Stewart et al., 1990). This technique involved identifying major themes and categories from each participant, and then examining common and uncommon themes across the complete dataset. This analysis was conducted by the PhD candidate and unclear classification of themes was clarified with an advisor.

4.3 Results

4.3.1 Participants

Eleven women interested in participating in the study contacted the investigator. The first eight participants screened for eligibility satisfied the inclusion criteria and were invited to participate in the study ($n = 8$). Participants ranged in age from 36 to 65 years (median = 49 years; IQR = 39 - 58.25 years), all spoke English at home, and the median BMI was 24.91 kg/m² (IQR = 23.34 - 36.73 kg/m²). The majority of participants were married (75%), employed in part-time or full-time capacity (63%), and had tertiary qualifications (75%). Time since the end of active breast cancer treatment for participants ranged from six months to 14.5 years (median = 3.75 years; IQR = 2.4 - 9.8 years). Self-reported text message use (sending or receiving of messages) prior to the start of the study ranged from

one text per day to ten texts per day (median = 3 texts/day; IQR = 1 - 5 texts/day). No new themes emerged from the interviews after the eighth interview.

4.3.2 Feasibility of delivering pilot intervention

The 'Optus EmailSMS' program was suitable and appropriate to deliver the text messages in the context of this two week pilot intervention. A high level of tailoring was possible due to manual creation of individual messages for each participant, manual scheduling and delivery of messages based on individual preferences, and the small sample size.

However, on a larger scale, over a longer time period, this process would be burdensome and time consuming. Furthermore, it was not possible to guarantee immediate feedback to goal check reply messages due to manual operation of the program (e.g., if a participant replied to a goal check message on a weekend, they may not have received a goal check reply until this was elicited by the PhD Candidate on Monday). A larger-scale intervention would require the capability of a more automated program to create, send, and promptly respond to text messages.

4.3.3 Acceptability of pilot intervention text messages

The majority of women reported that they found the telephone goal setting interview comprehensive, and as a result thought that the messages they received were written especially for them. All women agreed the text message language was appropriate, that there were no difficulties in understanding the abbreviations, and that the messages were simple and easy to read. On average, women opted to receive one or two messages per day for either one or both of the behaviours (median = 18; IQR = 11 - 25 texts per fortnight requested). Including goal check reply messages, the total frequency of messages sent to participants ranged from 14 to 42 text messages over the fortnight. Participants found it acceptable to receive messages related to multiple behaviours (i.e., physical activity and diet) as they often *"connected those together anyways"*, and did not feel overwhelmed even when receiving multiple messages on one day because *"they were for different purposes"* and *"were at [specific] times to remind me to do something"*. All participants expressed that the key to acceptability was the ability to individually tailor the content, frequency, and timing of their messages (e.g., *"It was good to get the text messages at the time I chose"*).

4.3.4 Effect of pilot text messages on behaviour

The majority of women reported that the two types of messages that were most supportive of behaviour change were ones that: 1) prompted a planned behaviour at a specific time (i.e., cue for planned behaviour message); and, 2) provided feedback on goal attainment (i.e., goal check reply message). All women found the messages received at a specific time that prompted a planned behaviour to be very helpful as it was seen as a “*very specific cue to action*” (e.g., go for a 30 minute walk now). A few women reported that these messages encouraged them to follow through with their planned activities even when they did not feel like doing the behaviour at the time.

“Yes, that message was excellent because I was actually sitting at my desk thinking, ‘I don’t want to go [walking] this afternoon’. So the message came through and I thought, ‘of course I can do this’ and I went to get my shoes”

Providing relatively immediate feedback in response to a participant’s reply to a goal check message was reported to be very important in maintaining program credibility and accountability, and fostering counsellor-participant rapport.

“Yes, it would have been different [if no reply to a goal check message was sent within 24 hours] because it’s like you are getting all of these messages and you are going ahead and doing them, but it’s like ‘why’? So, again the accountability, and you know someone is there monitoring everything...”

4.3.5 Suggestions for future intervention development

Participants were supportive of the concept of using text messaging to encourage maintenance of physical activity and dietary goals following an initial weight loss intervention.

“I can certainly see it being useful, especially after women have done six months with the support thing rather than being suddenly cut loose with nothing. It’s like a gradual tapering off so you are not feeling suddenly abandoned. Definitely worthwhile I think”

“Yes, for me personally, I think even one a fortnight would be enough. Like, ‘how are you going?’, ‘how did you do?’ and then give the feedback”

Participants commonly reported that they would have liked to have had the option to make adjustments to the way they were receiving messages had the study continued for more than two weeks (i.e., timing, frequency). Most participants agreed that a phone call was not necessary to make these revisions, and that they would feel comfortable and confident in communicating this via text message. However, participants were sceptical about the efficacy of exclusive text message contact in promoting maintenance of behaviour change and accountability to the program over a six month period. A few women suggested a 'check-in' telephone call during a longer study period may be needed to maintain program credibility, and re-establish rapport between participant and counsellor.

"Yes, I think it [text messages] would help, but I think you would have to be able to talk to someone as well. I don't think the texts are enough"

Participants appreciated the necessity to have automated messaging as a function in a larger scale program, but clearly communicated that some element of human involvement would need to be maintained to be effective.

"I definitely think the personal thing does come into it. They are still quite electronic and I know that you probably sat and did them all at once and that you weren't actually messaging me each single time. Coming from a computer generated thing is like an alarm going off, I personally didn't think I would learn anything. But I think the fact they were worded differently each time and fairly personalised, I felt as if you were there as my therapist"

In summary, participants enjoyed the study and all agreed that if the study was continuing that they would choose to continue receiving messages over a longer period of time to achieve longer-term physical activity and dietary goals.

"I think it could go for longer to really affect lifestyle change. If we were continuing I would have another goal to work on and I think that would give very positive outcomes"

4.4 Discussion and implications

The findings from this pilot study provided preliminary support for text messaging as an acceptable modality for delivering physical activity- and dietary-related messages to breast cancer survivors. Participants saw the value in all types of messages, with the cue for

planned behaviour and the goal check reply messages the most useful. Based on women's feedback, key elements of a successful text message-delivered intervention should include:

- (1) delivery of messages that are tailored to individual preferences for content, frequency and timing; and
- (2) delivery of responses to participant replies with minimal delay; and,
- (3) some telephone contact with the counsellor during the intervention period.

Despite some concerns in the literature regarding the suitability of text message-delivered interventions in a predominately older population (Greaney et al., 2012), this study provided support for the acceptability and feasibility of a text message delivery modality to promote healthful behaviours in breast cancer survivors. These findings also contributed to the evidence base supporting the use of mobile phone technology in promoting physical activity and dietary behaviour change simultaneously (Spring et al., 2012). Results suggest it is practical and feasible to target the promotion of these behaviours in 160 characters or less. It is important to note that these acceptability and feasibility findings may be dependent on specific participant characteristics in this small sample (i.e., most participants were employed, English-speaking, with tertiary education), but findings provide some preliminary support for the use of text messaging in an older, breast-cancer specific population.

These findings provided guidance for the development of a text message-delivered intervention promoting the maintenance of physical activity and dietary behaviour change in breast cancer survivors who completed the initial six month Living Well after Breast Cancer feasibility trial. Results highlighted the importance of text messages being perceived as highly tailored to individual preferences for message content, timing and frequency. In the context of a larger-scale intervention, it would be burdensome to create multiple highly-tailored messages for each individual, and impractical to use the Microsoft Outlook program to manually deliver text messages. This method would be a concern given relatively immediate feedback was reported to be associated with program credibility and accountability. Thus, findings indicated the automation of specific software delivery functions, whilst maintaining the high level of individual tailoring required to promote

personalised and relevant intervention content, would be required in a larger-scale intervention.

Lastly, it was important to consider that participants in this study were focused on initial behaviour change, whereas in a maintenance context, contact would be between a counsellor and participant who would have developed a stronger rapport during the initial intervention. However, it was important to acknowledge that some participants thought program accountability may be questionable over a longer-term intervention delivered solely via text message (i.e., in the absence of explicit 'human-to-human' contact). For this reason, an intervention targeting the maintenance of behaviour change delivered primarily via text message should include brief telephone contact. The findings from this study provided the foundation for the development of the Living Well after Breast Cancer extended contact intervention, discussed in detail in the following Chapter.

CHAPTER 5

DEVELOPMENT OF A TEXT MESSAGE-DELIVERED EXTENDED CONTACT INTERVENTION PROMOTING MAINTENANCE OF WEIGHT LOSS, AND PHYSICAL ACTIVITY AND DIETARY BEHAVIOUR CHANGE

5.1 Introduction

5.1.1 Context

Extended contact (i.e., continued contact after initial behaviour change) has been reported to be associated with weight loss maintenance (Jensen et al., 2014; Middleton et al., 2012), and successful long-term physical activity and dietary behaviour change (Artinian et al., 2010; Fjeldsoe et al., 2011). To date, two studies have reported text messaging as a feasible and acceptable modality to deliver an extended contact weight loss intervention in overweight adults (Donaldson et al., 2014) and African-American women (Gerber et al., 2009). Findings from the SMS-4-LW pilot study in Chapter Four provided support for the use of text messaging as an acceptable delivery modality to promote initial physical activity and dietary behaviour change in breast cancer survivors, a predominately older population. However, the efficacy of a text message-delivered extended contact intervention to promote the maintenance of physical activity and dietary behaviour change following a weight loss intervention in older adults has not yet been investigated.

5.1.2 Objective

This chapter provides detailed information regarding the development, content, and delivery of the Living Well after Breast Cancer extended contact intervention. The extended contact intervention was developed based on: Social Cognitive Theory (Chapter Two, Section 2.5.1); evidence for the theoretical mechanisms suggested to be important for maintenance of *behaviour change* (Chapter Two, Section 2.5.1; Appendix 2.A); the intervention strategies strongly supported by evidence to be important for the maintenance of *weight loss* (Chapter Two, Section 2.5.2); and, findings from the SMS-4-LW pilot study (Chapter Four). The aim of this chapter is to demonstrate the process the PhD candidate followed to develop the extended contact intervention, and to provide detail to understand

the intricacies of the intervention, which was difficult to convey in the restricted word count of the journal article resulting from this trial (Chapter Six).

5.2 Overview of the Living Well after Breast Cancer extended contact intervention

To promote the maintenance of weight loss and physical activity and dietary behaviour change, participants received individually tailored messages for a period of six months following the end of the initial Living Well after Breast Cancer feasibility trial. At the end of the initial Living Well after Breast Cancer feasibility trial, the extended contact intervention began with an initial tailoring telephone call with participants' health coach (Figure 5.1). The primary aims of this call were to: 1) gather information to individually tailor the text messages, and 2) determine individual preferences for the content, timing, and frequency of text messages. Message content focused on supporting participants to set and reach a longer-term weight loss/maintenance goal (i.e., 6 weeks), and a short-term goal focused on either physical activity and/or dietary behaviours (i.e., weekly). In line with evidence indicating the importance of tailoring intervention content to participant preferences, participants were given the flexibility to focus on either physical activity and/or dietary behaviours (Bull et al., 1999; Campbell et al., 1994). Message schedules were designed to be highly tailored to each participant, and dose was flexible and dependent on the level of support requested by each participant. To ensure message content was relevant for each participant for the duration of the intervention, tailoring information was updated during a 12 week tailoring call (Figure 5.1).



Figure 5.1: Living Well after Breast Cancer extended contact intervention study design

5.3 Theoretical basis of text message content

Self-regulation is a theoretical construct that refers to a group of strategies related to developing, implementing, and maintaining behaviours in order to achieve a goal (Bandura, 1986). Self-regulation has been identified as a key construct associated with successful *physical activity and dietary* behaviour change (Chapter Two, Section 2.5.1) and maintenance of *weight loss* (Chapter Two, Section 2.5.2). Thus, the primary function of each message was to target a strategy that would improve self-regulation skills of participants. Nine strategies have been identified by Abraham and Michie (2008) to elicit self-regulation in adults: prompt SMART goal setting; prompt self-assessment of goal attainment; provide feedback; prompt self-reward; prompt self-monitoring; prompt relapse prevention; prompt 'real-time' planned behaviour; prompt preparatory and planning behaviour; and, prompt barrier identification and solutions. In particular, there is strong evidence for the need for participants to regularly self-monitor their weight in order to maintain weight loss (Chapter Two, Section 2.5.2).

The four types of text messages created for the SMS-4-LW pilot study were modified to include these nine self-regulation strategies and also target weight loss maintenance. These modifications resulted in the development of four different types of text messages (Table 5.1):

1. Prompt to self-monitor weight
2. Goal check for weight, physical activity and diet
 - a. Goal check reply for weight, physical activity and diet
3. Goal reset for weight, physical activity and diet
4. Cue for planned behaviour for physical activity and diet

To ensure a variety of strategies were targeted in the messages, the cue for planned behaviour and the goal check reply messages also targeted five other constructs proposed to be associated with maintenance of weight loss and behaviour change (i.e., self-efficacy, social support, enjoyment, outcome expectancy, and perceived satisfaction with outcomes; see Chapter Two, Section 2.5.1 and Section 2.5.2; Appendix 2.A). For example, the primary function of the cue for planned behaviour

message prompted real-time planned behaviour, but also targeted participant's outcome expectancies (see 'cue for planned behaviour' message in Table 5.1).

Table 5.1: Examples of how self-regulation strategies were targeted across the five different types of text messages

Type of message	Self-regulation strategies targeted	Example
1. Prompt to self-monitor weight	Prompt self-monitoring	If u havent weighed yourself in the last fortnight Karen then do it today! Amy
2. Goal check	Prompt self-assessment of goal attainment	How r u going Karen? Reach ur goal 2 walk 3x30mins? Text me back yes or no. Amy
2a. Goal check reply	Provide feedback; Prompt self-reward; Prompt relapse prevention; Prompt "real-time" planned behaviour; Prompt self-monitoring; Prompt preparatory and planning behaviour; Prompt barrier identification and solutions	YES reply: Fantastic Karen! Regular exercise will help u control ur weight. Remember 2 buy a magazine & reward yourself 4 ur excellent effort. Amy NO reply: Don't worry Karen. Think about what got in the way & plan 4 it this week. Work around ur barriers 2 achieve ur goals. Amy
3. Goal reset	Prompt SMART goal setting	Reflect on ur exercise goals Karen. Eventually u want 2 aim for 7x30mins exercise/week & more is better. Text me back with a new goal! Amy
4. Cue for planned behaviour	Prompt "real-time" planned behaviour; Prompt self-monitoring; Prompt preparatory and planning behaviour; Prompt barrier identification and solutions	Want 2 feel more energised Karen? Make time 2 walk 3x30mins this week & feel the difference. Amy

5.4 Frequency and timing of text messages

The intervention was designed to give participants maximum flexibility in terms of text message frequency. Over the six month intervention, all participants received a minimum dose of weight-related messages (n = 18), and, depending on whether they chose to focus on physical activity and/or dietary behaviours, received goal reset messages for physical activity (n = 3) and/or diet (n = 3) at specified frequencies (Table 5.2). Participants could choose to receive additional messages targeting physical activity and/or dietary behaviours at their preferred dose and frequency (Table 5.2).

Table 5.2: Type of message for weight, physical activity, and diet, and the minimum dose and frequency for each type

Target	Type of message	Minimum dose	Frequency
Weight	Prompt to self-monitor weight	12	Fortnightly
	Goal check	3	Week 6, 18, 24
	Goal check reply	0	Triggered by participant's reply
	Goal resets	3	Week 6, 18, 24
Physical activity	Goal check	0	Maximum 2 per fortnight (participant determined)
	Goal check reply	0	Triggered by participant's reply
	Goal reset	3	Week 6, 18, 24
	Cue for planned behaviour	0	Maximum 4 per fortnight (participant determined)
Dietary behaviour	Goal check	0	Maximum 2 per fortnight (participant determined)
	Goal check reply	0	Triggered by participant's reply
	Goal reset	3	Week 6, 18, 24
	Cue for planned behaviour	0	Maximum 4 per fortnight (participant determined)

Based on the maximum frequencies for each type of message, a compendium of 250 text message frameworks was written by the PhD candidate. The full compendium shown in Appendix 5.A is categorised by target behaviour, text message type, and lists primary and secondary target constructs and strategies. All text messages were under 160 characters. The full compendium was reviewed by the PhD candidate and advisory team to ensure the adequate combination of target strategies and sequence, and clarify wording, meaning, and tone of the messages. The order of text messages in the compendium was designed to limit repetition of content, and also ensured that, regardless of the frequency of messages selected by each participant, they would receive messages targeting a range of strategies (i.e., those who elected a higher frequency of messages just received a higher dose rather than a greater range of strategies). Participants were advised that at any time, they were able to modify their message tailoring preferences by contacting a member of research staff via text message (or email or telephone if necessary).

5.5 Initial and week 12 tailoring calls

The initial tailoring call was conducted with participants' health coach (from the Living Well after Breast Cancer feasibility trial) at the beginning of the extended contact intervention and lasted approximately 20-30 minutes (i.e., at six-months; see Figure 5.1). Health coaches had qualifications in exercise physiology and/or dietetics, and participants had the same health coach for the duration of the intervention. The main objectives of this call were to: 1) orientate participants to the extended care intervention; 2) gather information to tailor the individual text messages; and, 3) determine participants' preferences for the content, timing, and frequency of text messages.

The week 12 tailoring call was a brief, 15-minute check-in call conducted halfway through the extended contact intervention (i.e., at week 12; see Figure 5.1). This call aimed to: 1) check attainment of weight and behavioural goals; 2) re-establish SMART goals for weight and physical activity and/or diet for the remaining 12 weeks of the extended contact intervention; and, 3) to review and make any necessary changes to tailored information and preferences for message content, timing, and frequency. The inclusion of this telephone contact was based on results from the SMS-4-LW pilot study, which suggested that minimal telephone contact may be needed to maintain accountability to a text message-based program, and to re-establish rapport with their health coach (see Chapter Four, Section 4.3.5).

The initial tailoring call (Appendix 5.B) and week 12 tailoring call (Appendix 5.C) were semi-structured and guided by scripts. Coaches recorded the initial tailoring call information on a participant profile sheet (Appendix 5.D), and the week 12 tailoring call information on the updated participant profile sheet (Appendix 5.E). The PhD candidate provided training to the coaches to explain the aim and focus of the calls, and gave specific instructions for call procedures and data collection as per the call scripts outlined in the Appendices above. The training took approximately 30 minutes to deliver.

5.6 Tailoring of the text message wording

A number of variables were used to individually tailor the wording of the text messages to each participant. This information was collected in the initial tailoring call and updated at the week 12 tailoring call. Messages were tailored based on participants':

Preferred name: Messages were addressed to participants using their preferred first name. Some first names were shortened to nick-names to reduce the number of characters required (e.g., Margaret to Marg).

Health coach's name: Messages were signed off by participants' health coach's name (e.g., Amy).

Weight goal: Participants nominated a six week weight loss or maintenance goal (e.g., to maintain 70kg). Participants were prompted to reset this goal at weeks 6, 18 and 24, and at the week 12 tailoring call.

Behavioural goal: Participants were required to set a six week SMART goal for physical activity and/or diet (e.g., to walk for thirty minutes three times per week; to eat five serves of vegetables per day). Participants were prompted to reset their goal/s at weeks 6, 18 and 24, and at the week 12 tailoring call.

Outcome expectancy: Participants nominated up to three anticipated outcomes they expected to be related to achieving their behavioural goal/s (e.g., an outcome expectancy of exercising three times per week may be to have more energy; an outcome expectancy of eating five serves of vegetables per day may be feeling satisfied for longer).

Preparatory action: Participants nominated up to two actions per behavioural goal that would help them plan and prepare to help them achieve their goals (e.g., a preparatory

action for physical activity may be putting walking shoes by the front door; a preparatory action for diet may be making lunch for the next day the night before).

Barriers to achieving goal: Participants nominated up to two barriers per behavioural goal that they saw as potentially stopping them from achieving their goal/s (e.g., a barrier to physical activity may be work commitments; a diet barrier may be the family getting takeaway on the weekend).

Solution to overcoming barriers: Participants were required to enlist problem solving skills and nominate how they were going to overcome their nominated barriers (e.g., a solution to the barrier of work commitments may be to exercise first thing in the morning; a solution to the barrier of family influencing the consumption of takeaway food may be to choose the healthy takeaway option).

Social support person: Participants gave the first name of a support person who could help them achieve their goal/s. This may include a partner, family member, friend, or work colleague (e.g., John).

Support provided by social support person: Participants nominated a specific action that their support person could do to try to support their behavioural goal/s (e.g., the participant may be able to go walking with John; John is able to help prepare healthy meals).

5.7 Text message delivery process

A web-based software program was custom-developed to deliver the text messages for the extended contact intervention. This software was developed in collaboration with a professional software development agency, and with significant conceptual and instrumental contribution from primary advisor, Dr Brianna Fjeldsoe. The software interfaced with a commercial telecommunication gateway through MessageMedia Pty Ltd to allow the sending and receiving of messages to individual participants.

The compendium of message frameworks and the information from participants' initial tailoring call were entered into the software by the PhD candidate. The software then combined the message frameworks with individual's tailoring variables to create individually-tailored messages. Individually-tailored sending schedules for each participant were also entered into the software. These schedules could be established in the software up to six months in advance and each type of text message (e.g., goal check messages)

had its own schedule. The software then automatically generated and sent messages according to these pre-scheduled times.

The software could also automatically recognise incoming goal check replies from participants and send tailored responses. When participants replied to a goal check message in the requested format (i.e., yes/no), the software sent a tailored response. If participants replied to a goal check message in an unexpected format (e.g., “I wasn’t able to fit in the third walk”) the software was unable to send an automatic reply. In this case, an email was sent to the PhD candidate flagging this unrecognised response. The PhD candidate then determined the appropriate goal check reply, and manually triggered the correct reply to be sent by the software. An email was also sent to the PhD candidate flagging responses to goal reset messages, and any messages that did not request a reply (e.g., a cue for planned behaviour message). This allowed the PhD candidate to: monitor participants’ progress in relation to changes to goals; modify message content, dose, or frequency schedules when requested; and, ensure those who were experiencing difficulties or certain situational events (e.g., surgery, illness) received appropriate responses. The PhD candidate refrained from sending messages that were not listed in the compendium, or sending messages out of sequence. However, where necessary, individual messages could be written and sent directly to participants if the triggered response was not appropriate. For example, if a participant reported being ill, the reply would mirror the compendium content but was re-worded to acknowledge the illness and send well wishes. While it was important to test the acceptability of the semi-automated functioning of the software, it was important to keep in mind that the close rapport developed between participants and their coaches (who were ‘sending’ these messages) needed to be maintained to ensure the accountability and ‘humanness’ of the program was upheld (an important finding from the SMS-4-LW pilot in Chapter Four).

5.8 Summary

In summary, this chapter detailed the development, content, and delivery of the Living Well after Breast Cancer extended contact intervention. The intervention was founded based on emerging evidence on the feasibility and acceptability of text messaging as a delivery modality to support maintenance of weight loss and related behaviours. Formative findings from the SMS-4-LW pilot study in Chapter Four were further applied to ensure the design and delivery of this intervention was tailored and acceptable. Outcomes from the evaluation of this intervention are reported in Chapter Six.

CHAPTER 6

EFFICACY, FEASIBILITY, AND ACCEPTABILITY OF A TEXT MESSAGE-DELIVERED EXTENDED CONTACT INTERVENTION IN BREAST CANCER SURVIVORS

6.1 Introduction

6.1.1 Context

The importance of maintenance of behaviour change in breast cancer survivors, and the need to investigate cost-effective and broad-reach delivery modalities suited for extended contact has been clearly outlined in Chapter Two (Section 2.1 and Section 2.3). The Living Well after Breast Cancer feasibility trial, a randomised controlled trial of a telephone-delivered weight loss intervention in overweight breast cancer survivors, provided an opportunity to evaluate how a six-month text message-delivered extended contact intervention influenced the maintenance of weight loss and behaviour change. The Living Well after Breast Cancer extended contact intervention was developed based on: 1) evidence of the theoretical constructs suggested to be important for maintenance of behaviour change (Chapter Two, Section 2.5.1); 2) the intervention strategies strongly supported by evidence to be important for the maintenance of weight loss (Chapter Two, Section 2.5.2); and, 3) and findings from the SMS-4-LW pilot study (Chapter Four).

6.1.2 Objective

The objective of this study was to evaluate the efficacy, feasibility, and acceptability of a text message-delivered extended contact intervention in promoting the maintenance of weight loss and physical activity and dietary behaviour change. Primary outcomes included long-term change (i.e., baseline to 18-months) in weight, moderate-to-vigorous physical activity, and energy intake. Secondary outcomes included perceived acceptability of the extended contact intervention and text messaging process outcomes.

It is important to note that energy intake was selected as a single indicator to evaluate dietary behaviour change. Based on this, it is acknowledged that implications of dietary behaviour change may be somewhat limited. Analysis of a range of indicators such as including fruit and vegetable intake and fat intake may afford more insight into dietary

behaviour change (Spahn et al., 2010), but given the complex and exploratory nature of this study, one comprehensive dietary indicator was used for simplicity.

The manuscript of this evaluation was submitted *the Journal of Medical Internet Research* in December 2014, and is currently under review. A copy of the submitted manuscript is below. The thesis appendices include materials participants received at the start of the extended contact intervention (Appendix 6.A - participant information sheet; Appendix 6.B - text message example sheet; Appendix 6.C - participant consent form) and the 12-month feedback interview materials (Appendix 6.D - quantitative feedback questions; Appendix 6.E - qualitative feedback interview script).

6.2 Efficacy of a text message-delivered extended contact intervention on maintenance of weight loss, physical activity and dietary behaviour change

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Efficacy of a Text Message-Delivered Extended Contact Intervention on Maintenance of Weight Loss, Physical Activity and Dietary Behavior Change

Abstract

Background: Extending contact with participants after the end of an initial intervention is associated with successful maintenance of weight loss and behavior change. However, cost-effective methods of extending intervention contact are needed.

Objective: This study investigated whether extended contact via text message was efficacious in supporting long-term weight loss and physical activity and dietary behavior change in breast cancer survivors.

Methods: Following the end of an initial six-month telephone-delivered weight loss intervention, eligible and consenting participants received a six-month extended contact intervention via tailored text messages targeting a range of factors proposed to influence the maintenance of behavior change. In this single-group, pre-post designed study, within group changes in weight, moderate-to-vigorous physical activity (Actigraph GT3X+ accelerometers), and total energy intake (2x24 hour dietary recalls) were evaluated from baseline to end of initial intervention (6-months), end of extended contact intervention (12-months), and after a no-contact follow-up (18-months) via linear mixed models. Feasibility of implementation was assessed through systematic tracking of text message delivery process outcomes, and participant satisfaction was assessed through semi-structured interviews.

Results: Participants at baseline (n=29) had a mean (SD) age of 54.9 (8.8) years, BMI of 30.0 (4.2) kg/m², and were recruited a mean of 16.6 (3.2) months post-diagnosis. From baseline to 18-months, participants showed statistically significantly lower mean (95% CI) weight (-4.2kg [-6.0kg, -2.4kg]; p<0.001) and higher physical activity (10.4mins/day [3.6mins/day, 17.2mins/day]; p = 0.003), but no significant differences in energy intake (p=0.200). Participants received a mean of eight text messages per fortnight (range 2-11), and reported a high rate of satisfaction.

Conclusions: In comparison to interventions without extended contact, results suggest text message-delivered extended contact may support the attenuation of weight regain and promote the maintenance of physical activity.

Keywords: Weight; physical activity; diet; mobile telephone; intervention; behavior change; maintenance

Introduction

Maintaining a healthy body weight, engaging in regular physical activity, and eating a healthy diet are important for reducing the risk of chronic disease [1-3]. Behavioral lifestyle interventions are effective at promoting initial weight loss [4] and supporting physical activity and dietary behavior change [5, 6]. However, maintaining improvements in these outcomes is often more difficult to achieve [7, 8]. Regain in weight and relapses in health behaviors are common following the end of intervention. Trials indicate an average of 0.3kg of weight is regained per month post-intervention [9, 10], and up to 50% of initial weight loss is re-gained within one year post-intervention [11]. The challenge in maintaining weight loss has been largely attributed to the failure in maintaining physical activity and dietary improvements [12].

Extending contact with participants after an initial intervention has been found to improve weight loss maintenance [13, 14] and support long-term physical activity and dietary behavior change [5, 15]. A recent review of extended contact interventions delivered via telephone or face-to-face reported overall average weight regain was 3.2kg less than in the corresponding control groups over approximately 18 months follow-up [13]. However, extended contact interventions delivered via face-to-face and telephone can be costly and time consuming [16, 17], while web-based delivery has been associated with poor participant retention and engagement [18, 19]. Mobile phone text messaging may be an ideal extended contact intervention delivery modality due to its cost-effectiveness and ability to provide highly tailored support to participants in 'real-time' [20, 21]. Emerging evidence supports the feasibility and acceptability [22] and efficacy [23, 24] of providing text message-delivered extended contact interventions to promote the maintenance of weight loss. However, no studies to date have explored the efficacy of a text message-delivered extended contact intervention to promote longer-term weight loss and associated physical activity and dietary behavior change.

This study aimed to assess the feasibility, acceptability, and efficacy of a six-month text message-delivered extended contact intervention on the maintenance of weight loss and physical activity and dietary behavior change. This single-group, pre-post-designed study provided: estimates of the effect sizes that may be achieved in a text message-delivered extended contact intervention; and, an opportunity to explore the relationship between text message dose and changes in weight and behavioral outcomes. The study aims were addressed in the context of the Living Well after Breast Cancer feasibility trial, a pilot randomized controlled trial evaluating a six-month telephone-delivered weight loss intervention (versus usual care) for breast cancer survivors. Participants completing the six-month telephone-delivered intervention were invited to receive a further six-month intervention delivered via text messages. Long-term changes in weight, physical activity, and diet were evaluated within this intervention group. The maintenance of weight loss and associated behaviors is particularly important for breast cancer survivors as increasing evidence suggests that obesity, physical inactivity, and a poor diet quality are associated with increased risk of cancer recurrence and mortality [25-29].

Methods

Study Design

Participants in the Living Well after Breast Cancer feasibility trial completed a baseline assessment and were randomized to the initial telephone-delivered intervention (n=45) or usual care group (n=45). Those completing the initial telephone-delivered intervention (n=40) were invited to participate in the text message-delivered extended contact intervention. This sample size was insufficient to allow further randomization to an extended contact intervention versus control group. Assessments were conducted at baseline, 6-months (end of initial intervention), 12-months (end of extended contact intervention), and 18-months (end of no-contact follow-up). The Living Well after Breast Cancer feasibility trial and extended contact intervention were conducted at The University of Queensland in Brisbane, Australia. Ethical approval was obtained from the Human Research Ethics Committee of The University of Queensland and Queensland Health Research and Governance Unit.

Participant Recruitment

The Living Well after Breast Cancer feasibility trial aimed to recruit overweight and obese women who had recently completed treatment for stage I-III breast cancer [30]. Women aged 18 to 75 years who had been diagnosed with stage I-III breast cancer in the previous 9-18 months and were living within a 50km radius of the state capital, Brisbane, were identified from the Queensland Cancer Registry. Eligible women had a body mass index (BMI) of 25-40kg/m² (i.e., overweight or obese), had completed primary cancer treatment (i.e., surgery, radiation, chemotherapy), and could speak sufficient English to participate in the intervention. Women were excluded if they had been diagnosed with ductal carcinoma in situ (DCIS; stage 0) or with distant metastatic disease (stage IV), had a previous diagnosis of invasive breast cancer, had been diagnosed with any other cancer in the past five years, had contraindications to participating in unsupervised physical activity due to poor health or a medical condition, or self-reported a mental health condition that would interfere with their participation in the study. Women currently using or planning to use weight loss medications or those who had or were planning bariatric surgery were also excluded. To be eligible for the extended contact intervention, participants needed to own a mobile phone and be able to read a text message sent to that phone. Those eligible and agreeing to participate provided written, signed consent for the initial and extended contact intervention phases.

Initial Weight Loss Intervention (Baseline to 6-months)

The initial intervention aimed to promote weight loss through the combination of increased physical activity, reduced energy intake, and behavioral change strategies [14, 31]. Intervention participants were mailed program materials (workbook, self-monitoring diary, scales, pedometer, calorie counter book) at the start of the intervention and received up to 16 telephone calls (6 x weekly calls followed by 10 x fortnightly calls) from a coach using motivational interviewing techniques [32]. Coaches were Accredited Practicing Dietitians [30] who received additional training in motivational interviewing and exercise promotion. Participants were encouraged to aim for the targets of: (i) weight loss of between 5-10% [33]; (ii) increasing moderate-vigorous physical activity to at least 30 minutes per day (210 minutes per week) [34]; and, (iii) improving dietary behaviors (reducing energy intake by 2000kJ per day; < 30% of total energy intake from fat; < 7% of total energy from saturated fat; 5 serves of

vegetables per day; 2 serves of fruit per day) [35, 36]. Participants were provided with a target kilojoule intake (between 5,000-7,500kJ/day) based on their baseline weight and age [37].

Extended Contact Intervention (6- to 12-months)

The extended contact intervention was primarily delivered via individually-tailored mobile phone text messages. The aim of this phase of the intervention was to promote sustained and/or ongoing improvements in weight loss and physical activity and dietary behavior change from the initial intervention. The design of the extended contact intervention was informed by: literature on maintenance of weight loss and behavior change [38-40]; formative research on text message usefulness and language with the target group (n=8); and, Social Cognitive Theory [41].

At the start of the extended contact intervention, participants completed a tailoring telephone call with their coach to gather information to determine individual preferences for the content, timing, and frequency of text messages. The text messages focused on supporting participants to reach a longer-term (i.e., six weeks) weight loss/weight maintenance goal, and a short-term (i.e., weekly) goal focused on either physical activity and/or dietary behaviors. To support participants to reach these goals, the text messages targeted self-regulation skills through nine evidence-based strategies [36, 42-44]: prompt SMART goal setting; prompt self-assessment of goal attainment; provide feedback; prompt self-reward; prompt self-monitoring; prompt relapse prevention; prompt 'real-time' planned behavior; prompt preparatory and planning behavior; prompt barrier identification and solutions. These strategies were reflected in five different types of text messages (Table 1).

Message dose (i.e., frequency) and timing (i.e., day of week and time of day) were tailored to each participant for each of the five message types (Table 1). All participants received a minimum dose of 21 text messages over the six-month intervention, including: 12 weight self-monitoring, three goal checks for weight, three goal resets for weight and, depending on whether participants chose to focus on physical activity and/or dietary behaviors, they also received three goal resets for physical activity and/or three for diet (see examples in Table 1). In addition to this minimum dose, participants could choose to receive additional messages targeting physical activity and/or dietary behaviors, including: goal checks (maximum for each behavior n=24), and cues for planned behaviors (maximum for each behavior n=48; Table 1).

Participants were encouraged to reply to goal check messages for weight, physical activity and/or diet (Table 1). If participants responded to these messages a tailored goal check reply message was sent (Table 1). Participants were also encouraged to reply to the goal reset messages (Table 1), and these data were used to update the tailoring information about their goals, but they did not receive a tailored response. Individually-tailored message content and sending schedules were entered into a web-based software program that interfaced with a commercial telecommunication gateway to allow the sending and receiving of messages to individual participants. To ensure message content remained relevant, participant tailoring information was updated during a 12-week tailoring telephone call with their coach.

Table 1. Examples of how self-regulation strategies were targeted across the five different types of text messages

Text message type	Strategies targeted in this type of message	Example	Minimum dose over six months			Frequency		
			Weight	PA	Diet	Weight	PA	Diet
Self-monitoring of weight	Prompt self-monitoring	If u havent weighed yourself in the last fortnight Karen then do it today! Amy	12	NA	NA	Fortnightly	NA	NA
Goal check	Prompt self-assessment of goal attainment	How r u going Karen? Reach ur goal 2 walk 3x30mins? Text me back yes or no. Amy	3	0	0	Once in weeks 6, 18, 24	Maximum 2 per fortnight (participant determined)	Maximum 2 per fortnight (participant determined)
Goal check reply	Provide feedback; Prompt self-reward; Prompt relapse prevention; Prompt “real-time” planned behaviour; Prompt self-monitoring; Prompt preparatory and planning behaviour; Prompt barrier identification and solutions	Yes example: Fantastic Karen! Regular exercise will help u control ur weight. Remember 2 buy a magazine & reward yourself 4 ur excellent effort. Amy No example: Don’t worry Karen. Think about what got in the way & plan 4 it this week. Work around ur barriers 2 achieve ur goals. Amy	Triggered by participant’s reply			Triggered by participant’s reply		
Goal reset	Prompt SMART goal setting	Reflect on ur exercise goals Karen. Eventually u want 2 aim for 7x30mins exercise/week & more is better. Text me back with a new goal! Amy	3	3	3	Once in weeks 6, 18, 24	Once in weeks 6, 18, 24	Once in weeks 6, 18, 24
Cues for planned behaviour	Prompt “real-time” planned behaviour; Prompt self-monitoring; Prompt preparatory and planning behaviour; Prompt barrier identification and solutions	Want 2 feel more energised Karen? Make time 2 walk 3x30mins this week & feel the difference. Amy	NA	0	0	NA	Maximum 4 per fortnight (participant determined)	Maximum 4 per fortnight (participant determined)

Data Collection and Outcomes

Data were collected at baseline, 6-, 12- and 18-months by trained research staff. Data collection involved an in-person assessment, two telephone interviews, and wearing an activity monitor for a period of seven days. Intervention participants received printed, tailored feedback on weight and behavioral outcomes following all assessments.

Feasibility Measures

Feasibility of implementation was assessed in relation to uptake of the intervention (i.e., consent rate and characteristics of those who consented to the extended contact intervention), and process outcomes related to the delivery of the extended care intervention (i.e., the number of messages sent; the rate of replies to goal check and goal reset messages; the rate of researcher intervention required to trigger goal check replies or alter content of text messages; and, the duration of the initial and check in telephone calls).

Efficacy Measures

Weight

Weight was measured in duplicate, without shoes or heavy clothing, using standard calibrated scales (nearest 0.1kg).

Physical Activity

Physical activity was measured using a tri-axial accelerometer (GT3X+, Actigraph, Florida, USA), worn for seven consecutive days during waking hours. Data were used to determine minutes per day spent in moderate-vigorous physical activity (counts \geq 1952) [counts \geq 1952; 45, 46]. Average moderate-vigorous physical activity on valid days (i.e., 10+ hours of wear) was then multiplied by 7 to yield a weekly estimate.

Energy Intake

Energy intake was measured using two, unprompted 24-hour dietary recalls (recalling one weekday and one weekend day). The dietary recalls were conducted via telephone using FoodWorks® Interview (version 1, 2009, Xyris Software, Brisbane), based on a 5-stage multi-pass method [47]. Participants were provided with a food model booklet to assist in portion size estimation and food quantities. Dietary intake was analyzed using Foodworks® Professional Edition (version 6, 2009, Xyris, Brisbane) nutritional analysis software to determine total energy intake (kJ/day). The average of energy intake over the two recalled days was used.

Participant Acceptability Measures

At the 12-month assessment, participants were invited to participate in a one-on-one semi-structured interview to assess satisfaction with the extended contact intervention. A five-point Likert scale was also used to assess the helpfulness of the text messages (from 1 'very unhelpful' to 5 'very helpful').

Statistical Analyses

The sample size for the extended contact intervention was determined by the number of participants completing the initial intervention (n=40). Data analysis was performed using SPSS for Windows (version 21) and statistical significance was set at $p < 0.05$ (two-tailed). Changes from baseline at 6-, 12- and 18-months for each outcome are reported. Change scores (follow-up minus baseline) had approximately normal

distributions. Changes from 6- to 12- months and from 12- to 18-months are also reported. Data were analyzed, separately for each outcome, using linear mixed models, with random intercepts for each subject to account for repeated measures. Models included time (baseline, 6-, 12- or 18- months) and adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment. These latter variables were included to correct for observed changes in group composition between 6-, 12- and 18-months caused by dropout [48]. This method was used to handle missing data rather than baseline-value-carried-forward (BVCF), as BVCF can overstate maintenance by not allowing participants who drop out to experience any decline (or gain). The association of dose of number of text messages received (treated as a continuous variable) with change in weight and physical activity and diet from baseline was examined by adding this variable to the linear mixed models. Process outcomes were evaluated descriptively. Participant acceptability was determined through semi-structured interview questions, and thematic analysis of the qualitative interview data followed a systematic and iterative process [49]. This technique involved identifying major themes and categories from each participant, and then examining common and uncommon themes across the complete dataset.

Results

Feasibility outcomes

Participant Recruitment and Characteristics

Figure 1 shows the flow of participants through the study. Forty-five women were randomized to the initial intervention, with 40 (88%) completing the 6-month assessment. Of these women, 36 were eligible to participate in the extended contact phase and 30 (83%) consented to participate, with one participant later becoming ineligible due to a recurrence. Twenty-five (86%) extended contact intervention participants completed the 12-month assessment, and 23 (79%) completed the 18-month assessment.

Participants at baseline had a mean (SD) age of 54.9 (8.8) years, BMI of 30.0 (4.2) kg/m², and were recruited a mean of 16.6 (3.2) months post-diagnosis and 7.1 (1.4) months post-treatment completion (Table 2). Compared to participants who completed all follow-up assessments (n=23), participants who withdrew (n=6) were more likely to be younger (mean 56 years vs. 49 years), have a lower BMI (mean 30.5 kg/m² vs. 28.2 kg/m²) and be employed (65% vs. 100%), and less likely to have a high household income (32% vs. 17%).

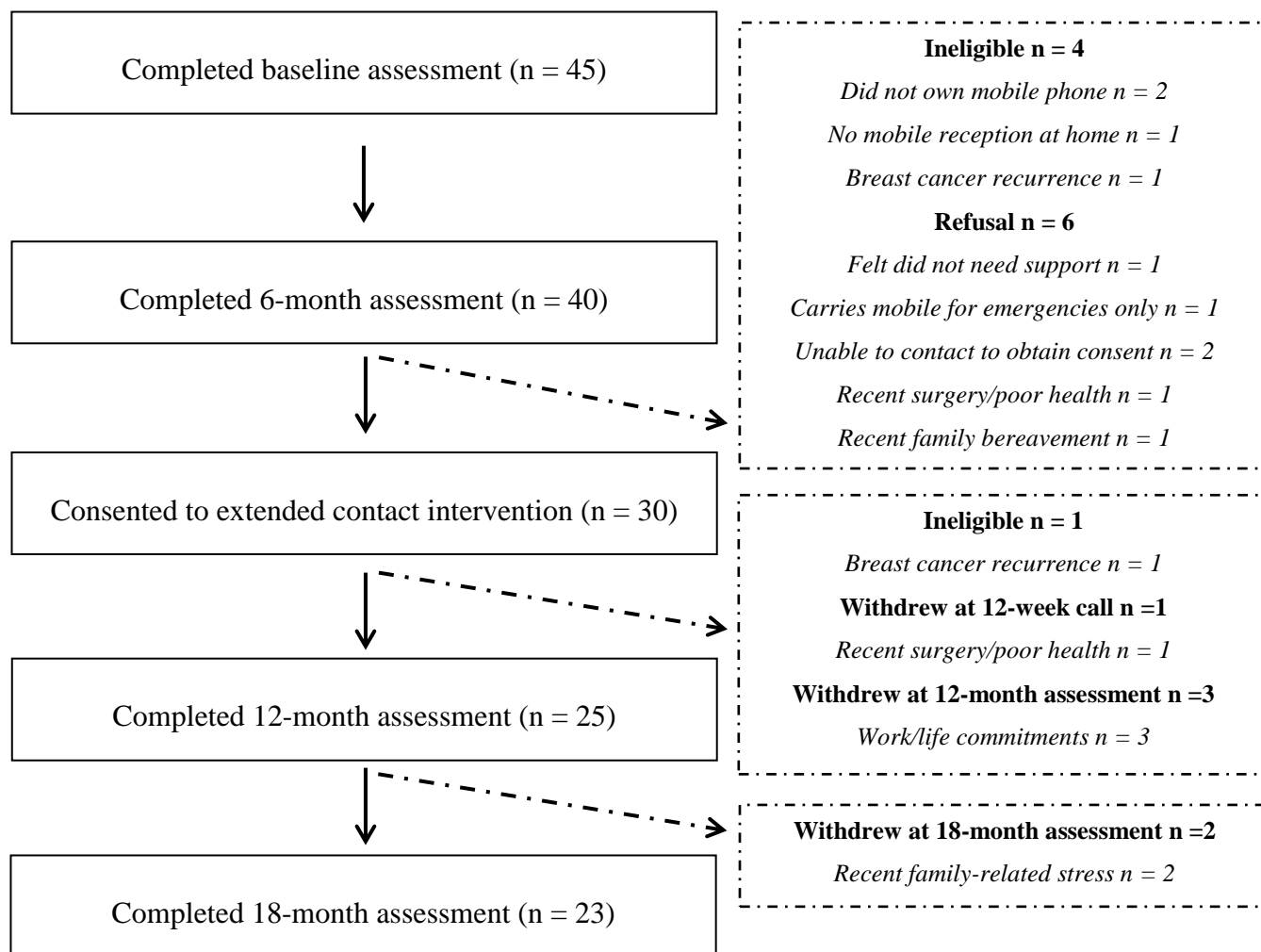


Figure 1. Flow of participants from baseline to the final 18-month assessment

Table 2. Baseline characteristics of participants who consented to the extended contact intervention (n=29)

Characteristics	Mean (+/- SD)
Age (years)	54.9 (8.8)
Weight (kg)	81.8 (13.1)
BMI (kg/m ²)	30.0 (4.2)
Time since diagnosis (months)	16.6 (3.2)
Time since treatment (months)	7.1 (1.4)
	% (n)
Caucasian	97% (28)
Married/defacto	83% (24)
High household income (>\$2391+/wk) ^a	28% (7)
Completed high-school	76% (22)
Completed tertiary education	34% (10)
Employed (full-time, part-time, casual)	72% (21)
Post-menopausal	59% (17)
Stage I; Stage II-III	48%; 52% (13; 14)
Mastectomy	38% (11)
Chemotherapy	62% (18)
Radiation	79% (23)
Endocrine therapy	69% (20)

^a Household income of >\$2391+ per week is within the top two quintiles based on the Australian population [50]

Extended Contact Intervention Process Outcomes

Participants chose to receive text messages focused on both physical activity and diet (n=12), or focused just on physical activity (n=11) or diet (n=6). Completing participants (n=25) received an average of 74 (range 25-135) text messages over the 6-month intervention. This equated to an average of approximately eight text messages per fortnight (range 2-11), typically comprised of: 1 x weight self-monitoring, 3 x cues for planned behavior, 2 x goal checks, 1 x tailored goal check reply, 1 x goal reset. Overall, participants replied to every two in three goal check messages (67% response rate), and every one in five goal reset messages (20% response rate). Less than half of the overall goal check reply messages were automatically sent to participants (41%), with researcher intervention required most of the time to either trigger the appropriate 'yes' or 'no' goal check reply (36%) or alter the content of the message to be appropriate to the participant reply (23%).

The initial telephone consultation with the coach lasted 22 minutes on average (minimum-maximum:11-40 minutes). The 12-week check in telephone call lasted 16 minutes on average (minimum-maximum:8-31 minutes), and 88% of participants (n=22) used this call to update their goals or alter their text message content. The requested changes during this call were mostly to change the behavioral focus of messages (e.g., from physical activity- to diet-focused; n=3), or to increase (n=2) or decrease (n=2) the frequency of messages received. Two participants were not able to be contacted to receive a 12-week check in telephone call, and their tailoring information remained the same for the full six months.

Efficacy outcomes

Weight

Overall, mean weight at 6-, 12-, and 18-months was statistically significantly lower than baseline (**Figure 2; Multimedia Appendix 1**). There was a small but non-significant increase in weight during the extended contact intervention (1.3kg [95% CI: -0.5, 3.1]; $p = 0.211$), with weight remaining relatively stable over the no-contact follow-up period (-0.1kg [95% CI: -1.9, 1.8]; $p = 1.000$). Participants lost a mean of 6.8% (95% CI: 4.7%, 8.8%) of baseline weight during the initial intervention and regained 1.6% (95% CI: -0.6%, 3.8%) of baseline weight (23.5% of initial weight lost) during the extended contact intervention. At 18-months, participants had statistically significantly lower mean weight (-4.2kg [-6.0kg, -2.4kg]; $p < 0.001$) compared to baseline, and on average had lost 5.2% (95% CI: 3.0%, 7.4%) of body weight.

Physical Activity

Participants significantly increased their moderate-to-vigorous physical activity from baseline at 6- and 18-months (**Figure 3; Multimedia Appendix 1**). Physical activity at 12-months was not significantly different to baseline. Physical activity decreased but not significantly during the extended contact intervention (-6.1 mins/day [95% CI: -14.9, 2.8]; $p = 0.260$), and increased but not significantly during the no-contact follow up (7.8 mins/day [95% CI: -1.6, 17.2]; $p = 0.132$).

Diet

Participants significantly decreased their energy intake from baseline at 6-months and 12-months (**Figure 4; Multimedia Appendix 1**). Energy intake at 18-months was not significantly different to baseline. Energy intake increased, but not statistically significantly, during both the extended contact intervention (364 kJ/day [95% CI: -609, 1338]; $p = 0.735$) and the no-contact follow-up (416kJ/day [95% CI: -620, 1451]; $p = 0.690$).

Text Message Dose

Each additional text message received per week was associated with 9.5 minutes per day [95% CI: 3.1, 15.8; $p = 0.004$] more physical activity at 18-months. There was no significant association between weekly text message dose and change in weight (1.3kg [95% CI: -0.3, 2.8]; $p = 0.098$) or change in energy intake (279kJ/day [95% CI: -157, 716]; $p = 0.198$).

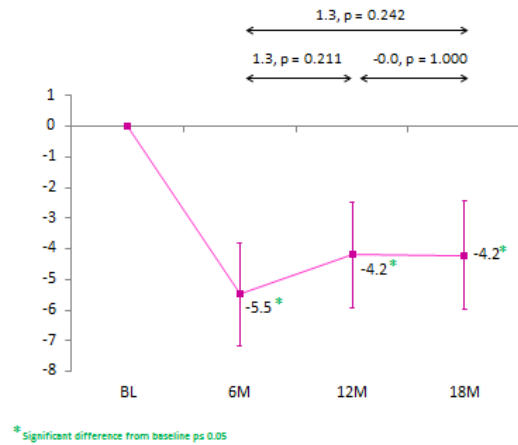


Figure 2: Change in weight (kg) from baseline and between follow-up timepoints.

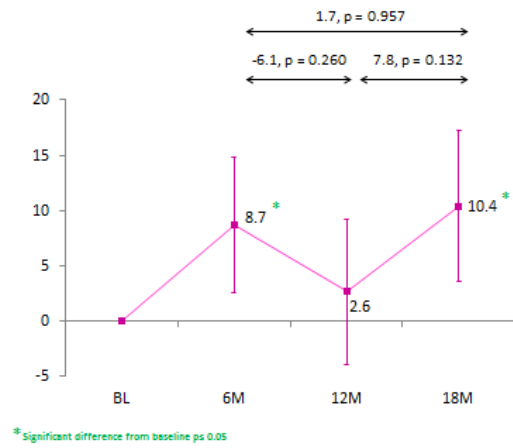


Figure 3: Change in physical activity (mins/day) from baseline and between follow-up timepoints.

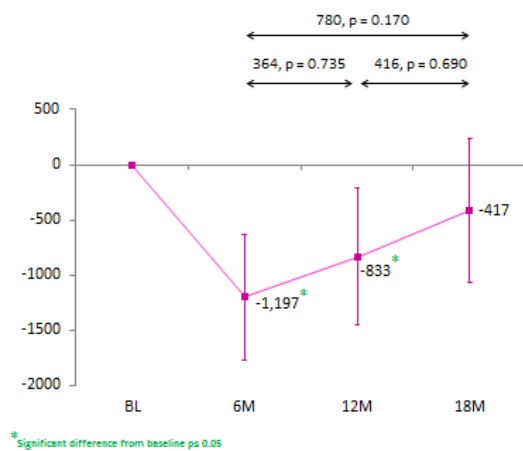


Figure 4: Change in energy intake (kJ/day) from baseline and between follow-up timepoints.

Participant Acceptability Outcomes

Of the 25 participants completing the extended contact intervention, 80% reported the extended contact as either 'very helpful' (n=6; 24%) or 'helpful' (n=14; 56%), and 20% (n=5) reported the extended contact as 'neither helpful nor unhelpful'. The majority of women reported that the text messages primarily served as a prompt or reminder for a specific behavioral cue to action, fostered accountability to keep on track, and that the text message content was sufficiently personalized. Overall, participants highly valued the goal check reply messages and the 12-week check in telephone call as they provided a 'human' element of contact important for ongoing feedback and accountability.

Discussion

The aim of this study was to explore the feasibility, acceptability, and efficacy of a six-month text message-delivered extended contact intervention in promoting the maintenance of weight loss and physical activity and dietary behavior change in breast cancer survivors who completed an initial six-month telephone delivered weight loss intervention. Overall, results suggest extended contact may have helped to attenuate weight regain, and promote the maintenance of long-term change in physical activity. The highly tailored text message-delivered extended contact intervention was also feasible to deliver and acceptable among this sample of primarily older breast cancer survivors.

Importantly, mean weight at 18-months follow-up was significantly lower than at baseline (approximately 5.2% of initial body weight loss). Evidence from a large number of previous weight loss trials suggests that average weight regain following an intervention is in the order of 0.3kg per month post-intervention [9, 10] or approximately 50% of weight lost is regained within 12-months post-intervention [51]. In comparison, the magnitude of weight regain observed here was considerably less (approximately 0.1kg per month or 23.5% regain of initial weight loss over a 12-month period). This study adds to the limited evidence to date on the efficacy of text messaging to support weight loss maintenance.

Donaldson and colleagues [23] examined a three-month text message-delivered extended contact weight loss intervention following an initial three-month face-to-face weight loss intervention, finding that it resulted in an additional 1.6kg weight loss at the end of the extended contact intervention compared to a regain of 0.7kg weight regain in the no-contact control group [23]. A one-month text message-delivered behavior change intervention following a commercially available weight loss program reported 87% of participants regained less than 3% of initial weight loss at three-months follow-up [24]. However, these studies focused on relatively short-term maintenance outcomes making comparison with outcomes here difficult [23, 24]. Together, these findings provide emerging support for the use of text messaging to deliver extended contact interventions to promote weight loss maintenance.

Reporting on changes in physical activity and energy intake (the behaviors that underpin weight loss maintenance) following extended contact interventions has been limited. Overall, studies suggest that changes in physical activity are largely maintained at the end of an extended contact intervention [9, 52-57], but maintenance of dietary behavior change appears more challenging [9, 56, 57]. Contrary to these previous

findings, physical activity in this study had relapsed by the end of extended contact but rebounded by follow-up, while the opposite pattern of behavior was observed for energy intake. This inconsistent pattern of physical activity and dietary behavior change to weight change is mirrored in findings from the broader weight loss maintenance literature [9, 56, 57]. However, it is important to acknowledge the long-standing caveat of correlating changes in physical activity and diet as measured at a single point in time with more cumulative changes in weight.

Determining significant dose-response relationships between text message dose and behavioral outcomes may help to inform the development of future extended contact interventions. Every additional text message received per week in this study was associated with a mean increase of more than one hour of physical activity per week at follow-up. This suggests the dose of extended intervention contact received may influence the maintenance of long-term behavior change outcomes, but has yet to be examined in other studies. A larger scale intervention that allows personalized tailoring could examine the minimum dose of text messages received whereby a significant maintenance effect is no longer observed.

The acceptability of the delivery modality to the target group also influences intervention success [7]. Consistent with findings from previous studies exploring text message-delivered extended contact interventions to promote the maintenance of weight loss and behavior change [22, 23], satisfaction ratings were high. Notably, the intervention completion rate was higher than previously reported in a younger population (86% vs. 58%; [23]). This is promising given skepticism regarding the suitability of text message-delivered interventions in older adults [58].

Participants received a wide range of text message dose and this reflects the feasibility to deliver a highly tailored extended contact intervention. Participant engagement with replying to messages was high, although researcher intervention was often required to provide suitably tailored feedback. Future text message-delivered extended contact interventions should integrate more sophisticated software and programming approaches, such as those applied in mobile phone application behavior change tools to improve automation while maintaining a high level of participant tailoring [59, 60]. However, our qualitative findings suggest that technology-driven interventions should maintain an element of 'human' connection to foster ongoing participant satisfaction and accountability. A highly automated text message-delivered extended contact intervention may therefore need to be supplemented with additional non-automated contact, such as that delivered via telephone or email.

A number of study limitations should be considered in interpreting results. This study was largely exploratory as it was not feasible to re-randomize participants following the initial intervention due to the small sample size in the larger trial in which this study was embedded. Establishing intervention acceptability among an older population group such as breast cancer survivors is a strength of the study, but may also limit the generalizability of results to broader populations. Measurement error may have contributed to differences in patterns and magnitude of behavioral outcomes. Comparisons of behavior change outcomes to previous literature were difficult due to the limited number of studies that report post-intervention behavioral outcomes. This highlights the importance of future studies including post-intervention assessments to

further examine how patterns of behavior change may influence weight loss maintenance.

In summary, findings from this study support the feasibility, acceptability, and efficacy of a text message-delivered extended contact intervention to promote the maintenance of weight loss and physical activity among a predominately older female subgroup. There is a growing evidence base supporting the utility of text messaging as an intervention delivery modality [20, 21, 61, 62], with this study being the first to report on outcomes of a text message-delivered extended contact intervention to support long-term maintenance of weight loss and behavior change. Results suggest providing extended contact via text messaging after an initial intensive weight loss intervention may help attenuate weight regain and promote long-term physical activity behavior change compared to what otherwise would be observed without extended contact. Randomized controlled trials with larger and more diverse samples are needed, along with comparative effectiveness and cost-effectiveness trials comparing text messaging with other delivery modalities that might be suited to extended contact interventions (e.g., mobile phone applications).

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Conflict of Interest

None declared.

Multimedia Appendices

Multimedia Appendix 1. Mean changes in weight, physical activity, and energy intake from baseline and between the follow-up time points

		Weight (kg)	MVPA (mins/day)	Energy intake (kJ/day)
Baseline	Mean ±SD	81.7 ± 13.1	27.3 ± 18.8	7862 ± 1982
6MΔ ^a	Mean (95% CI)	-5.5 (-7.2, -3.8)	8.7 (2.6, 14.8)	-1197 (-1768, -626)
	p	<0.001	0.006	<0.001
12 MΔ ^a	Mean (95% CI)	-4.2 (-5.9, -2.5)	2.6 (-3.9, 9.2)	-833 (-1452, -214)
	p	<0.001	0.423	0.009
18 MΔ ^a	Mean (95% CI)	-4.2 (-6.0, -2.4)	10.4 (3.6, 17.2)	-417 (-1067, 233)
	p	<0.001	0.003	0.200
12MΔ-6MΔ ^b	Mean (95% CI)	1.3 (-0.5, 3.1)	-6.1 (-14.9, 2.8)	364 (-610, 1338)
	p	0.211	0.260	0.735
18MΔ-12MΔ ^b	Mean (95% CI)	-0.0 (-1.9, 1.8)	7.8 (-1.6, 17.2)	416 (-620, 1452)
	p	1.000	0.132	0.690
18MΔ-6MΔ ^b	Mean (95% CI)	1.3 (-0.5, 3.1)	1.7 (-7.5, 10.9)	780 (-223, 1784)
	p	0.242	0.957	0.170

Footnote: Analyses carried out under intention-to-treat principles for all participants at baseline and 6-months, and then completers from this sample at 12- and 18-months [BL=29; 6M=29; 12M=25; 18M =23]

^a Mean changes from baseline, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment ^b Differences in change between follow-up time points, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

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6.3 Summary

This study was the first to implement a text message-delivered extended contact intervention to promote the maintenance of weight loss and physical activity and dietary behaviour change in breast cancer survivors. This study was largely conducted as a feasibility trial due to the absence of a control group and insufficient power due to a small sample size. The findings from this study provided preliminary support for the feasibility, acceptability, and efficacy of a text message-delivered extended contact intervention to promote the maintenance of weight loss and physical activity behaviour change in breast cancer survivors, a predominately older female population. Importantly, the mean age of participants in this study were representative of breast cancer patients aged less than 75 years in Australia (mean 54.9 ± 8.8 versus 54.8 ± 10.1 ; Schmitz et al., 2012). Overall, results suggested extending contact via text messaging after an initial intensive weight loss intervention may help attenuate weight regain and promote long-term physical activity behaviour change in this population compared to what otherwise may be expected without ongoing contact. Future studies need to consider randomised controlled trials with larger sample sizes to further explore the efficacy of text message-delivered extended contact interventions to promote the maintenance of weight loss and behaviour change compared to no-contact control conditions and/or other intervention delivery modalities. Further implications of these findings are discussed in Chapter Eight.

CHAPTER 7

PREDICTORS OF SHORT- AND LONG-TERM PHYSICAL ACTIVITY AND DIETARY BEHAVIOUR CHANGE

7.1 Introduction

Findings from the evaluation of the Living Well after Breast Cancer extended contact intervention (Chapter Six) suggested that an extended contact intervention delivered via text messaging, following an initial telephone-delivered weight loss intervention, was feasible and acceptable, and reported efficacy in promoting long-term maintenance of weight loss and physical activity. This chapter explores the underlying theoretical constructs and participant characteristics associated with short- (baseline to 6-months) and long-term (baseline to 12-months; baseline to 18-months) changes in physical activity and dietary behaviour for participants in the Living Well after Breast Cancer extended contact intervention. It is important to explore these intervention and participant characteristics to further understand how the intervention may have successfully targeted underlying constructs to influence behaviour change, and to determine for whom the intervention worked best (and least) for. It is particularly important to identify these factors because promoting long-term behaviour change is challenging, and understanding the behaviour change mechanisms associated with short- and long-term change at an individual level can help inform the selection, refinement, and tailoring of specific intervention designs and strategies to better promote the initiation and maintenance of behaviour change (Lawler et al., 2014; Michie et al., 2010; Van Stralen et al., 2009).

This chapter summarises the theoretical constructs and participant characteristics that were explored in this study, and details the study objectives, design, methods, and results. Implications and considerations of the findings in comparison to previous literature are also discussed.

7.2 Summary of theoretical constructs explored in this study

This study focused on exploring seven specific theoretical constructs that underpinned the Living Well after Breast Cancer extended contact intervention (detailed in Chapter Five, Section 5.3), and have been commonly proposed to be associated with short- and/or long-

term physical activity and/or dietary behaviour change (detailed in Chapter 2, Section 2.5.1; Appendix 2.A). These constructs were:

- Self-regulation
- Outcome expectancy
- Satisfaction with outcomes
- Self-efficacy
- Social support
- Perceived environmental opportunity
- Enjoyment (physical activity only)

7.3 Summary of participant characteristics explored in this study

A limited number of studies to date have explored the participant characteristics associated with physical activity and dietary behaviour change in breast cancer survivors (Courneya et al., 2009; Emery et al., 2009; Hertogh et al., 2010; Vallance et al., 2010). The participant characteristics explored in this study were divided into two categories of variables:

- Demographic (i.e., income, employment, marital status, education, age, ethnicity), and
- Health-related (i.e., time since breast cancer diagnosis and treatment, stage of breast cancer, mastectomy surgery, chemotherapy treatment, radiation treatment, endocrine treatment, chronic health conditions, body mass index, smoking status).

7.4 Objective

The objective of this chapter was to identify the theoretical constructs and participant characteristics associated with short-term (baseline to 6-months) and long-term (baseline to 12-months; baseline to 18-months) physical activity and dietary behaviour change.

Specific sub-objectives included:

- To examine changes in theoretical constructs targeted in the intervention from baseline to 6-, 12-, and 18-months;
- To examine the relationship between changes in the theoretical constructs and physical activity and dietary behaviour change (i.e., change in constructs from

baseline to 6-, 12-, and 18-months that was associated with change in physical activity and dietary behaviour from baseline to 6-, 12-, and 18-months, respectively); and,

- To examine the relationship between demographic and health-related participant characteristics with physical activity and dietary behaviour change (i.e., baseline participant characteristics that were associated with change in physical activity and dietary behaviour from baseline to 6-, 12-, and 18-months).

It was the initial intent of this study to explore the *mediators* of behaviour change to determine whether change in theoretical constructs *directly caused* change in physical activity and dietary behaviour (Bauman et al., 2002; Cerin et al., 2009). However, the current study did not have a sample size with sufficient statistical power to conduct mediator analyses. Therefore, this study explored the *predictors* of behaviour change.

Determining predictors of behaviour change can identify variables *associated* with behaviour change and help generate hypotheses about *potential* causal pathways (Bauman et al., 2002; Cerin et al., 2009). Determining predictors of behaviour change is a two-step process and involves exploring: 1) whether the intervention significantly changed individual theoretical constructs; and, 2) whether changes in these constructs were associated with changes in the outcome behaviour (Cerin et al., 2009). It is important to note that although there were no *significant* findings for long-term dietary behaviour in the Living Well after Breast Cancer extended contact intervention, it was still informative to determine whether changes in constructs were associated with changes in dietary behaviour on an individual level.

7.5 Study design and participants

The study design and participant sample of the Living Well after Breast Cancer extended contact intervention are detailed in the manuscript in Chapter Six (Section 6.2), and briefly summarised here.

7.5.1 Study design

Participants were initially randomised into the Living Well after Breast Cancer feasibility trial, a six-month telephone-delivered weight loss trial, or a no-contact control group. The initial six-month telephone-delivered intervention aimed to promote weight loss through

increased physical activity and reduction in energy intake. At the end of the six-month initial intervention, participants in the intervention group were invited to participate in the extended contact intervention. The aim of the extended contact intervention was to promote sustained and/or ongoing improvements in weight loss and physical activity and dietary behaviour through individually-tailored mobile phone text messages. Participants received no intervention contact during the final six-month no-contact post-intervention period (see Figure 7.1 for an overview).

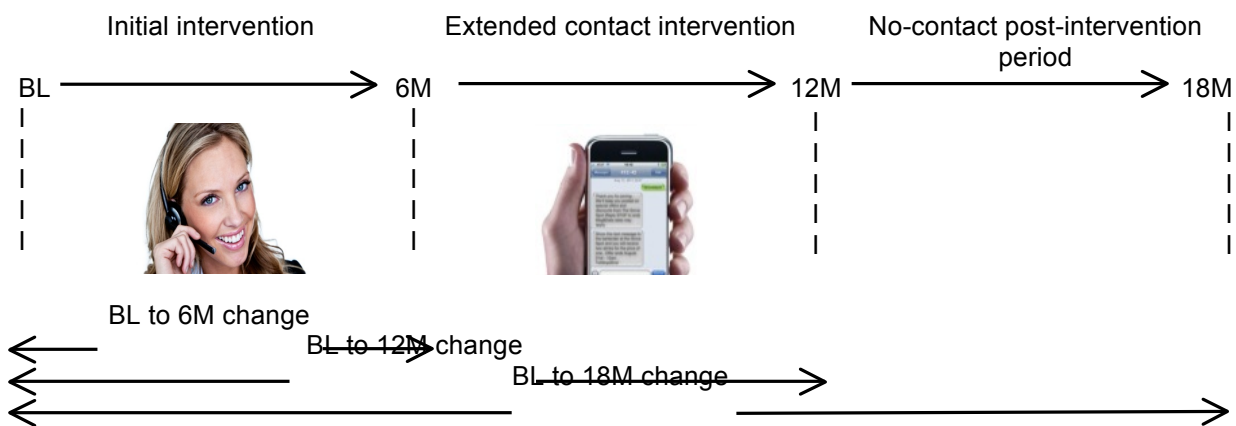


Figure 7.1: Overview of design of Living Well after Breast Cancer extended contact intervention and corresponding periods of change

7.5.2 Participants

A summary of participant characteristics from those who consented to the extended contact intervention is detailed in Chapter Six, Table 2. In summary, women who consented to the extended contact intervention ($n = 29$) had a mean age of 55 years and were typically Caucasian, had completed high school, were employed, married or in a defacto relationship, and post-menopausal. Participants were on average about 18 months post-diagnosis with the majority of participants having received adjuvant treatment (i.e., chemotherapy, radiation and/or endocrine treatment), and were approximately seven months post-treatment.

7.6 Assessment of theoretical constructs

The seven theoretical constructs assessed included: self-regulation; outcome expectancy, satisfaction with outcomes, self-efficacy, social support, perceived environmental opportunity, and enjoyment (physical activity only). These were assessed for each behaviour separately (i.e., self-efficacy for physical activity, self-efficacy for diet), but enjoyment was assessed for physical activity only (as guided by the evidence reviewed in Chapter Two, Section 2.5.1). Constructs were assessed through a self-administered questionnaire at baseline, 6-, 12-, and 18-months (Appendix 7.A). The measures in the questionnaire were adapted from existing published tools to ensure they were: 1) specific to physical activity and/or dietary behaviours; 2) suitable for a breast cancer survivor population; and, 3) culturally appropriate for Australia. Details of the processes and principles for adaptation of each measure are outlined in further detail in Appendix 7.B. An overview of how each construct was measured and details of reliability, validity, and sample population of the original measure is shown in Table 7.1.

Table 7.1: The number of items and reference for scales modified to measure the theoretical constructs

Construct	Behaviour	Items	Questionnaire items (Appendix 7.A)	Stem question	Item example	Scale range	Original measure, sample, and validity/reliability indicators
Self-efficacy	Physical activity	7	Part D, Items 8-14	How confident are you that you would be able to exercise when...	- you get very busy - you are sore or tired	1 = not at all confident; 5 = extremely confident	Linde et al. (2006) Overweight adults, predominately female Internal consistency: $\alpha = 0.91$ for physical activity; $\alpha = 0.87$ for diet
	Diet	7	Part D, Items 1-7	How confident are you that you would be able to choose healthy food options when...	- you are bored - you are on holidays		
Self-regulation	Physical activity	20	Part C, Items 20-39	The next questions are about how often you used various strategies to help you exercise. In the past month...	- I wrote down my exercise goals - I rewarded myself for reaching my exercise goals	1 = never; 5 = very often	Petosa (1993) Young, middle-aged adults Internal consistency: $\alpha = 0.88$ overall; $\alpha = 0.82-0.96$ for subscales
	Diet	19	Part C, Items 1-19	The next questions are about how often you used various strategies to help you eat healthy food. In the past month...	- I set short-term dietary goals (daily or weekly) - I planned to overcome barriers to my dietary goals		
Social support	Physical activity	10	Part E, Items 11-20 (Items 16-17 reverse scored)	During the past month, how often have your friends, family, or members of your household...	- exercised with you? - given you encouragement to stick with your exercise program?	1 = never; 5 = very often	Sallis et al. (1987) Adults and undergraduate students Internal consistency $\alpha = 0.61-0.91$; Test-retest reliability $r = 0.55-0.86$
	Diet	10	Part E, Items 1-10 (Items 6-10 reverse scored)		- reminded you not to eat unhealthy foods? - complimented you on eating healthy foods?		
Enjoyment	Physical activity	1	Part B, Item 25	Please indicate the extent to which you agree or disagree with the statement:	- I enjoy exercising	1 = strongly disagree; 5 = strongly agree	Rogers et al. (2005) Breast cancer patients
Perceived environmental opportunity	Physical activity	8	Part F, Items 9-16	Please indicate the extent to which you agree or disagree with each of the following statements:	-my home is within a 10-15 minute walk to a bus stop or train station -there are footpaths on most of the streets in my neighbourhood	1 = strongly disagree; 5 = strongly agree	Inoue et al. (2009) Japanese adults Test-retest reliability of subscales: $r_s = 0.79-0.99$; $K = 0.63-0.97$
	Diet	8	Part F, Items 1-8 (Items 5-6 reverse scored)		-where I shop has a large selection of fresh fruit and vegetables -where I go for takeaway has a large selection of healthy options		Dibsdall et al. (2003) Low-income adults Internal consistency $\alpha = 0.55-0.98$ for subscales Moore et al. (2008) Adults Internal consistency $\alpha = 0.78$ Test-retest reliability (ICC) = 0.69
Outcome expectancy	Physical activity	12	Part A, Items 13-24 (Items 21-24 reverse scored)	I believe that engaging in regular exercise will lead to...	- improved mental wellbeing - improved physical health	1 = strongly disagree; 5 = strongly agree	Rogers et al. (2004) Courneya et al. (2006) Breast cancer patients
	Diet	12	Part A, Items 1-8 (Items 9-12 reverse scored)	I believe that eating a healthy diet will lead to...	- feeling good - more energy		Zunft et al. (1997) European adults
Satisfaction with outcomes	Physical activity	12	Part B, Items 13-24	Please indicate the extent to which you agree or disagree with the statement:	- I am satisfied that my current level of exercise lowers my stress levels - I am satisfied that my current level of exercise gives me more confidence	1 = strongly disagree; 5 = strongly agree	Courneya et al. (2006) Breast cancer patients
	Diet	12	Part B, Items 1-12		- I am satisfied that my current diet has helped me to lose weight - I am satisfied that my current diet helps to reduce the risk of breast cancer returning		

7.7 Assessment of participant characteristics

7.7.1 Demographic variables

Demographic variables examined in the analysis included: weekly household income, employment status, marital status, education level, and age. The effect of ethnicity was considered but not assessed due to all except one participant being Caucasian.

Demographic data were collected during a telephone interview at baseline (Appendix 7.C).

7.7.2 Health-related predictors

Breast cancer-related and other health-related predictors included: time since breast cancer diagnosis, time since breast cancer treatment completion, stage of breast cancer, mastectomy surgery, chemotherapy treatment, radiation treatment, endocrine treatment, presence of chronic health conditions, body mass index (BMI), and smoking status. Data on time since breast cancer diagnosis and breast cancer stage were extracted from the Queensland Cancer Registry pathology reports. Data on time since breast cancer treatment completion, mastectomy surgery, chemotherapy treatment, radiation treatment, endocrine treatment, chronic health conditions, and smoking status were collected during the telephone interview at baseline (Appendix 7.C). Weight was measured during the in-person assessment at baseline, 6-months, 12-months, and 18-months. Measurements were conducted in duplicate, without shoes or heavy clothing, using standard calibrated scales (nearest 0.1kg). Height was measured in duplicate, without shoes, using a stadiometer (nearest 0.1cm) during the in-person assessment at baseline only. Baseline BMI was calculated as weight (kilograms) divided by height (metres) squared. The effect of smoking was considered but not assessed due to no participants identifying as current smokers.

7.8 Assessment of behavioural outcomes

7.8.1 Moderate-to-vigorous physical activity

Physical activity was objectively measured using tri-axial accelerometers (GT3X+, Actigraph, Florida, USA), worn for seven consecutive days during waking hours. Data, collected in 60 second epochs, were used to determine minutes per day spent in moderate-to-vigorous physical activity (counts \geq 1952; Freedson et al., 1998; Healy et al., 2007). Automated estimates of accelerometer wear time were cross-checked against the

participant-completed wear log and invalid days of observation (i.e., days with < 10 hours wear) were discarded.

7.8.2 Dietary energy intake

Dietary intake was measured using two, unprompted 24-hour dietary recalls (recalling one weekday and one weekend day). The dietary recalls were conducted via telephone using FoodWorks® Interview (version 1, 2009, Xyris Software, Brisbane), based on a 5-stage multi-pass method (Conway et al., 2003). Participants used a food model booklet to assist with estimating portion sizes. Dietary intake was analysed using Foodworks® Professional Edition nutritional analysis software (version 6, 2009, Xyris, Brisbane) to determine total energy intake (kJ/day).

7.9 Data treatment

7.9.1 Treatment of theoretical construct data

To be included as a valid response, 70% of items within each construct scale needed to be answered. Items for each measure were then averaged to give a mean score on a scale from 1 to 5 for each participant. Models were run using partially standardised predictor variables (i.e., change in behaviour associated with change in 1 SD of each predictor variable) rather than unstandardized predictor variables (i.e., change in behaviour associated with change in 1 unit of the Likert scale of each predictor variables) to enable comparison of change in variables across constructs. This was done for conceptual reasons as it can be more meaningful to compare change between different theoretical constructs by examining differences in the change in standard deviation versus differences in the change in scaled units. This is because different constructs may require different magnitudes of behaviour change to move between units on a scale (e.g., moving from a 1 to a 2 in self-efficacy may not necessarily require the same magnitude of change compared to moving from a 1 to 2 in social support).

7.9.2 Treatment of participant characteristic data

Demographic variables were categorised into dichotomous variables for: weekly household income (\$2930+ per week, yes/no), employment status (paid employment, yes/no), marital status (married or living together, yes/no), and education level (completed tertiary, yes/no). Age remained a continuous variable. Weekly household income of

\$2930+ per week represents the top quintile (20%) of income based on Australian Bureau of Statistics data for the Australian population in 2009-10 (Australian Bureau of Statistics, 2011).

Health-related variables were categorised into dichotomous variables for: time since breast cancer diagnosis (>18 months; yes/no), time since breast cancer treatment completion (>12 months; yes/no), stage of breast cancer (stage 2+; yes/no), mastectomy surgery (mastectomy; yes/no); chemotherapy treatment (chemotherapy; yes/no), radiation treatment (radiation; yes/no); endocrine treatment (endocrine; yes/no); and, absence of chronic health conditions (none; yes/no). Body mass index (BMI) remained a continuous variable.

7.10 Data analysis

Data analysis was performed using SPSS for Windows (version 21) and statistical significance was set at for $p < 0.05$ (two-tailed). Due to the small sample size and the already underpowered nature of the analyses, the alpha value was not adjusted to account for multiple comparisons given the effect that decreasing type I error would have had on increasing type II error (Feise, 2005; Rothman, 1990). All data were double entered for data checking purposes. Data cleaning included checking continuous variables for normality.

7.10.1 Theoretical constructs

All theoretical constructs were treated as continuous variables. To assess change in theoretical constructs over time, linear mixed models were used to assess standardised change in each variable from baseline to 6-, 12-, and 18-months. Linear mixed models were used to assess change in theoretical constructs associated with short-term change (baseline to 6-months) and long-term change (baseline to 12-months; baseline to 18-months) in the outcome variables. Models were run separately to examine change in each construct from baseline to 6-, 12-, and 18-months associated with change in each outcome variable from baseline to 6-, 12-, and 18-months, respectively. Random intercepts were used for each subject to account for repeated measures. Models adjusted for: mean standardised baseline value of the construct; mean-centered baseline value of the outcome variable; and selected participant characteristics (age, income, time since diagnosis, and chemotherapy treatment). These participant characteristics were included

to correct for key changes caused by dropout as they explained significant variance in the standard error of timepoint in the model. This method was used to handle missing data rather than last-value-carried-forward (LVCF) or baseline-value-carried-forward (BVCF), as LVCF and BVCF can overstate successful long-term change by not allowing participants who drop out to experience any decline (Chakraborty et al., 2009).

7.10.2 Participant characteristics

Participant characteristics were treated as either continuous (i.e., age, time since diagnosis, time since treatment, BMI) or dichotomous categorical variables (i.e., income, employment, marital status, education, stage of cancer, mastectomy surgery, chemotherapy treatment, radiation treatment, endocrine treatment, number of chronic health conditions). Linear mixed models were used to assess participant characteristics at baseline that were associated with short-term change (baseline to 6-months) and long-term change (baseline to 12-months; baseline to 18-months) in the outcome variables. Models were run separately to examine each baseline participant characteristic associated with change in each outcome variable from baseline to 6-, 12-, and 18-months. Random intercepts were used for each subject to account for repeated measures. For continuous variables, models adjusted for: the mean value of the baseline participant characteristic; mean-centered baseline value of the outcome variable; and selected participant characteristics (age, income, time since diagnosis, and chemotherapy treatment). For categorical variables, models adjusted for: mean-centered baseline value of the outcome variable; and selected participant characteristics (age, income, time since diagnosis, and chemotherapy treatment). For continuous and categorical variable models, the participant variables were included to correct for key changes caused by dropout as explained above in Section 7.10.1.

7.11 Results

Due to the large number of variables examined, results presented below are limited to a sub-set of significant findings that contributed towards answering the research objectives. Full results are presented in Appendices 7.D to 7.I.

7.11.1 Summary of changes in physical activity and dietary behaviour

As reported in detail in Chapter Six, participants overall significantly improved physical activity and dietary behaviour during the initial intervention, reported some decline in favourable behaviours during the extended contact intervention, and reported continued improvements in physical activity but worsening of energy intake during the no-contact follow-up. Overall, participants significantly increased their moderate-to-vigorous physical activity by about 10 minutes per day from baseline to 18-months (Figure 7.2), and decreased their daily energy intake by 400 kJ per day from baseline to 18-months, although this was not statistically significant (Figure 7.3).

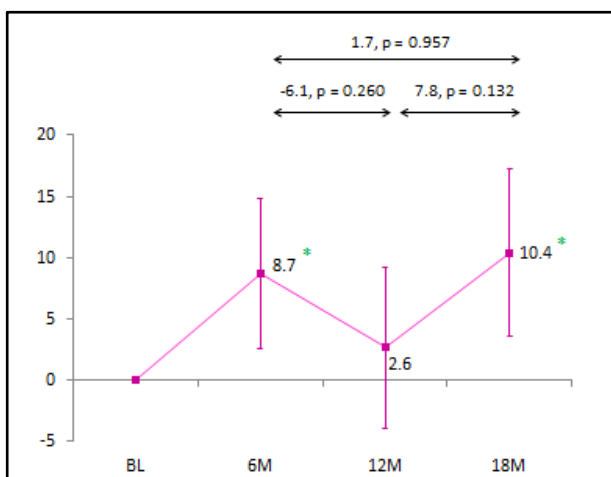


Figure 7.2: Change in moderate-to-vigorous physical activity (mins/day) from baseline to 6-, 12-, and 18-months

* Significant difference from baseline $p \leq 0.05$

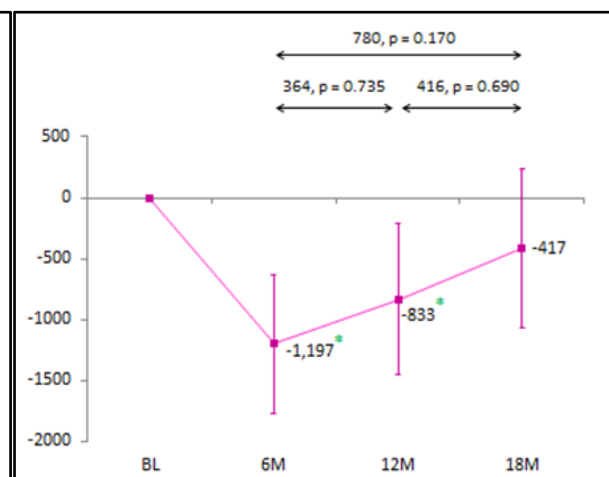


Figure 7.3: Change in energy intake (kJ/day) from baseline to 6-, 12-, and 18-months

* Significant difference from baseline $p \leq 0.05$

7.11.2 Change in theoretical constructs across the intervention

Standardised mean change in scores of physical activity- and diet-related theoretical constructs from baseline to 6-, 12- and 18-months are reported in Appendix 7.D and 7.E, respectively. Statistically significant increases and decreases in standardised mean change in scores are summarised in Table 7.2 below. Physical activity-related outcome expectancy, satisfaction with outcomes, self-regulation, and self-efficacy significantly

increased from baseline to 6-, 12-, and 18-months. Enjoyment in physical activity significantly increased from baseline at 12-months only. Diet-related satisfaction with outcomes, self-regulation, and self-efficacy significantly increased from baseline to 6-, 12-, and 18-months. Diet-related social support significantly increased from baseline to 6-months and baseline to 18-months, and outcome expectancy significantly increased from baseline to 12-months. Physical activity- and diet-related perceived environment and physical activity-related social support did not significantly change from baseline at any of the follow-up assessments.

Table 7.2: Summary of significant changes in theoretical constructs

Theoretical construct	6MΔ ^a	12 MΔ ^a	18 MΔ ^a
<u>Physical activity-related</u>			
Self-regulation	↑	↑	↑
Outcome expectancy	↑	↑	↑
Satisfaction with outcomes	↑	↑	↑
Self-efficacy	↑	↑	↑
Social support	-	-	-
Perceived environment	-	-	-
Enjoyment	-	↑	-
<u>Diet-related</u>			
Self-regulation	↑	↑	↑
Outcome expectancy	-	↑	-
Satisfaction with outcomes	↑	↑	↑
Self-efficacy	↑	↑	↑
Social support	↑	-	↑
Perceived environment	-	-	-

^a Significant ($p \leq 0.05$) increase (↑) or decrease (↓) in mean standard deviation of theoretical construct from baseline, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

7.11.3 Change in theoretical constructs associated with change in physical activity and dietary behaviour

Standardised mean change in scores of physical activity- and diet-related theoretical constructs associated with mean change in minutes of physical activity per day and mean

change in energy intake per day from baseline to 6-, 12- and 18-months are reported in Appendix 7.F and 7.G respectively. Significant findings are summarised in Table 7.3, with graphical representations displayed in Figures 7.4 and 7.5.

An increase of one standard deviation of self-efficacy from baseline to each timepoint was associated with an average increase of 8 minutes per day of physical activity from baseline to each timepoint (95% CI = 1.9, 13.1; $p = 0.011$; Figure 7.4). An increase of one standard deviation of outcome expectancy from baseline to 18-months was associated with an increase of 18 minutes per day of physical activity from baseline to 18-months (95% CI = 10.2, 24.9; $p < 0.001$; Figure 7.4). An increase of one standard deviation of perceived environment from baseline to 18-months was associated with an increase of 23 minutes per day of physical activity from baseline to 18-months (95% CI = 13.0, 33.3; $p < 0.001$; Figure 7.4).

An increase of one standard deviation of social support from baseline to each timepoint was associated with an average decrease in energy intake of 420kJ per day from baseline to each timepoint (95% CI = -842, -3; $p = 0.049$; Figure 7.5).

Table 7.3: Summary of significant findings of associations of changes in theoretical constructs with changes in physical activity and energy intake

Construct	Behaviour	Overall association		Timepoint interaction	6MΔ ^a		12 MΔ ^a		18 MΔ ^a	
		β (95% CI)	p		Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p
Self-efficacy	Physical activity	7.5 (1.9, 13.1)	0.011	-	-		-		-	
Outcome expectancy	Physical activity	-	-	<0.001	-		-		17.6 (10.2, 24.9)	<0.001
Perceived environment	Physical activity	-	-	<0.001	-		-		23.2 (13.0, 33.3)	<0.001
Social Support	Energy intake	-422 (-842, -3)	0.049	-	-		-		-	

^a Units = mean change in 1 standard deviation of psychosocial variable associated with mean change in mins/day of physical activity or kJ/day for energy intake from baseline as reported in the table, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

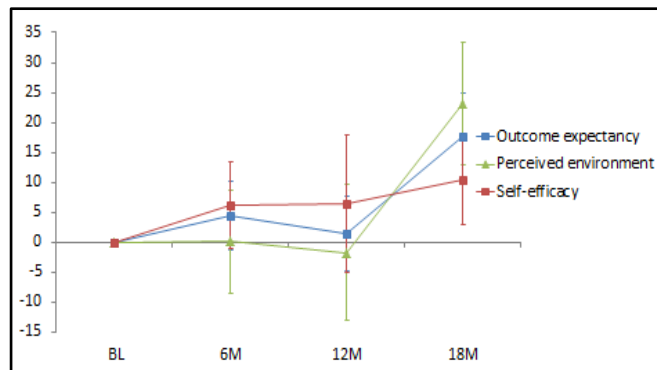


Figure 7.4: Change in outcome expectancy, self-efficacy and perceived environment significantly associated with change in physical activity (mins/day)

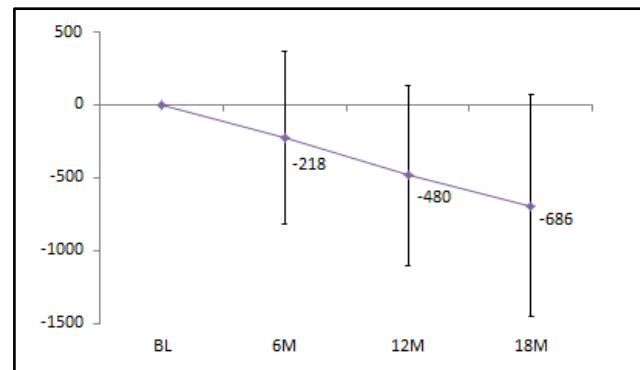


Figure 7.5: Change in social support significantly associated with change in energy intake (kJ/day)

7.11.4 Baseline participant characteristics associated with change in physical activity and dietary behaviour

Baseline demographic and health-related participant characteristics associated with mean change in minutes of physical activity per day and mean change in energy intake per day from baseline to 6-, 12- and 18-months are reported in Appendix 7.H and 7.I, respectively. Significant findings are summarised in Table 7.4 below, with graphical representations displayed in Figures 7.6 to 7.8.

Overall for physical activity, participants who were employed engaged in less physical activity at each timepoint than participants who were not employed (-16.6 mins/day; 95% CI = -26.8, -6.3; $p = 0.004$; see Figure 7.6). Participants who had endocrine treatment engaged in less physical activity at 18-months than participants who had not received endocrine treatment (-26.9 mins/day; 95% CI = -42.0, -11.8; $p = 0.001$; Figure 7.7).

Participants who completed treatment more than 12 months ago reported significantly lower energy intake at 12-months (-2784 kJ/day; 95% CI = -4804, -765; $p = 0.038$) and 18-months (-3118 kJ/day; 95% CI = -5188, -1048; $p = 0.004$) than participants who completed treatment less than 12 months ago (see Figure 7.8).

Table 7.4: Summary of significant findings of associations of baseline participant characteristics with changes in physical activity and energy intake

Characteristic	Behaviour	Overall association		Timepoint interaction	6MΔ ^a		12 MΔ ^a		18 MΔ ^a	
		β (95% CI)	p		Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p
Employed (employed vs. not employed)	Physical activity	-16.6 (-26.8, -6.3)	0.004	-	-		-		-	
Endocrine treatment (yes vs. no)	Physical activity	-	-	0.003	-		-		-26.9 (-42.0, -11.8)	0.001
Time since treatment (>12mths vs. <12mths)	Energy intake	-	-	0.009	-		-2784 (-4804, -765)	0.038	-3118 (-5188, -1048)	0.004

^a Units = Baseline participant characteristic variable associated with mean change in mins/day of physical activity or kJ/day for energy intake from baseline as reported in the table, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

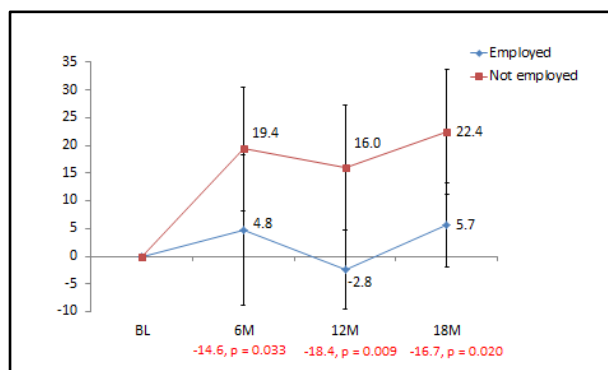


Figure 7.6: Changes in physical activity (mins/day) from baseline by employed vs. not employed

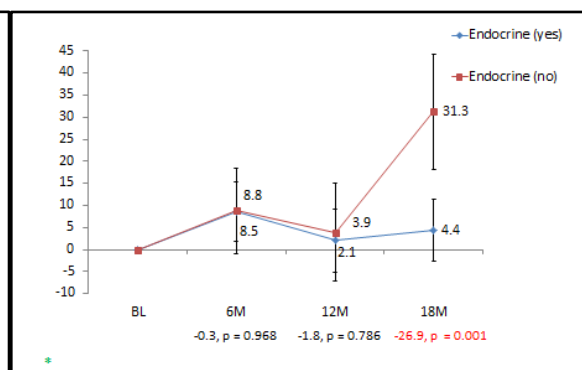


Figure 7.7: Changes in physical activity (mins/day) from baseline by endocrine treatment yes vs. no

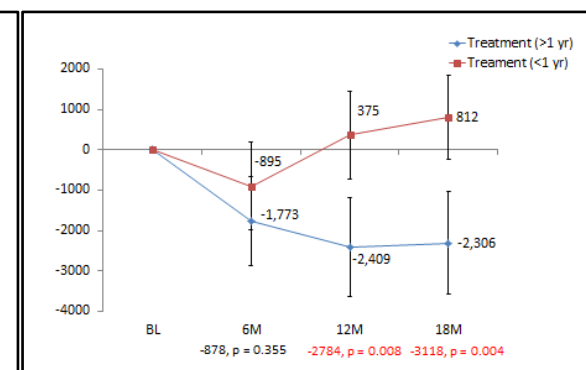


Figure 7.8: Changes in energy intake (kJ/day) from baseline by treatment > 1yr vs. treatment <1 yr

7.12 Discussion and implications

This Chapter aimed to explore the theoretical constructs and participant characteristics that predicted successful physical activity and dietary behaviour change in a group of breast cancer survivors. The analyses in this chapter were exploratory in nature and findings are interpreted with caution due to the small sample size that may have contributed towards a lack of statistically significant findings. However, no other study has looked at these constructs congruently across short- and long-term physical activity and dietary behaviour change in breast cancer survivors, so these findings hold importance for informing the development of behaviour change interventions for this population.

Results suggest that the initial and extended contact interventions were successful in changing most short- and long-term theoretical constructs, with the exception of physical activity-related social support and perceived environment for both physical activity and diet. Previous studies similarly report successful short-term (Rhodes et al., 2010; Short et al., 2013a) and long-term changes (Dallow et al., 2003; Hallam et al., 2004) in physical activity-related self-efficacy, self-regulation, and outcome expectancy, and there is some but limited support for changes in these constructs in the dietary behaviour change literature (Anderson et al., 2010; Anderson et al., 2001; Winett et al., 2007). However, overall it appears that changing constructs more distal to the individual, such as social support and perceived environment were not as successful in this intervention.

Significant change was observed for diet-related social support but not physical activity-related social support. These findings largely mirror the broader literature which similarly report mixed findings in relation to successfully targeting short- and long-term social support for physical activity (Rhodes et al., 2010; Short et al., 2013a). Delivering intervention content directly to nominated support people to encourage supportive strategies (i.e., providing tangible support) may further help promote social support for physical activity behaviour change, and this strategy has been successfully delivered in studies promoting physical activity in women (Fjeldsoe et al., 2010a) and breast cancer survivors (Demark-Wahnefried et al., 2014).

The intervention was not successful in improving women's perceptions of their environment for supporting physical activity or dietary behaviour change. Growing evidence supports the importance of the 'perceived' and 'actual' environment in promoting

physical activity and dietary behaviour change (King et al., 2006; Wendel-Vos et al., 2007). However, influencing the 'actual' environment is difficult in the absence of any direct power to change community infrastructure or policy (Duncan et al., 2005). Limited attention and limited guidance has been directed towards exploring the strategies that may be used in individual-level behaviour change interventions to influence 'perceived' environment (Humpel et al., 2002). One study in older adults found that physical activity interventions should discuss convenience and accessibility to footpaths and public recreation facilities to influence change in perceived neighbourhood environment (Booth et al., 2000). Future individual-level behaviour change interventions could consider including strategies such as: providing participants with maps that include walking and cycling paths that also detail healthy takeaway food option locations; or providing free vouchers to local facilities such as pools and gyms to improve perceived environment for convenience, access, and opportunity to engage in physical activity.

In terms of constructs associated with physical activity behaviour change, participants who reported greater improvements in self-efficacy for physical activity reported significantly greater changes in short- and long-term physical activity, while improvements in outcome expectancy and perceived environment were specifically important for long-term physical activity change. The association of self-efficacy with short- and long-term physical activity change and outcome expectancy with long-term change is reflected in the broader literature reporting on interventions based on Social Cognitive Theory (Rhodes et al., 2010; Short et al., 2014). More recently, focus has shifted to the importance of the environment in influencing the maintenance of physical activity (Calogiuri et al., 2014; Caperchione et al., 2014). Recent research indicates that interventions that promote outdoor physical activity rather than indoor physical activity are associated with better long-term physical activity behaviour change (Hekler et al., 2013). In addition, emerging evidence suggests perceived opportunity to engage in physical activity indirectly influences physical activity through impacting on social support and self-efficacy (Kegler et al., 2014). This means that neighbourhood perceptions play a direct and indirect role in shaping physical activity behaviour by influencing social support and confidence in one's ability to be active. However, regular physical activity may result in greater *awareness* of opportunities available, rather than more opportunities 'causing' greater physical activity participation (Booth et al., 2000; Wendel-Vos et al., 2007). Future studies need to explore mediational analyses to determine the relative importance, and direction of influence, of

perceived environment compared to individual-level constructs in influencing physical activity behaviour change (Anderson et al., 2010; Fjeldsoe et al., 2013; Hansen et al., 2014; Lawler et al., 2014; Toobert et al., 2010).

In terms of constructs associated with dietary behaviour change, participants who reported greater changes in social support for diet reported significantly greater changes in both short- and long-term dietary behaviour. There is limited evidence reporting on the importance of social support for healthy eating in promoting long-term dietary behaviour change (Anderson et al., 2010; Lawler et al., 2014), but findings from the weight loss maintenance literature indicate the absence of ongoing social support for dietary behaviour change is associated with poor long-term dietary outcomes (Metzgar et al., 2014). It has been established that long-term dietary behaviour change is particularly difficult to achieve (Svetkey et al., 2008; Wing et al., 2006), and findings reported here suggest that fostering social support may help attenuate common relapses in dietary behaviour change. While evidence suggests ongoing social support provided by a health professional supports maintenance of behaviour change (Toobert et al., 2010; Van Stralen et al., 2009), social support provided by friends and family may help foster longer lasting and more meaningful social support (Delormier et al., 2009). Future interventions should include specific strategies to promote improved social networks among family and friends. This may include delivering components of an extended contact intervention to a nominated support person or boosting social support through combining text messages with social media channels (Hwang et al., 2014; Napolitano et al., 2013; Williams et al., 2014). Future research could also explore strategies that engage social networks of family and friends while raising awareness of environmental opportunities to engage in physical activity and healthy eating in local areas to strengthen these pathways to ultimately promote long-lasting behaviour change.

It was surprising that the association between change in self-regulation and change in physical activity was not significant (although it did approach significance; $p = 0.067$), particularly given self-regulatory skills underpinned the primary focus of the intervention. The lack of association between change in self-regulation and change in physical activity is also contrary to the literature that commonly supports this relationship (Rhodes et al., 2010; Rogers et al., 2011; Short et al., 2013a). However, directly applying the constructs of health behaviour change models to directly explain behaviour change may be overly

simplistic. Behaviour change is complex, whereby individual, social, and environmental constructs interact and influence each other, resulting in direct and indirect pathways to behaviour change. For example, various studies report self-regulatory skills indirectly influence physical activity and dietary behaviour change through constructs including self-efficacy (Anderson-Bill et al., 2011; Anderson et al., 2006; Annesi et al., 2010; Dishman et al., 2005; Rovniak et al., 2002), social support (Anderson-Bill et al., 2011; Anderson et al., 2006), and also the environment (Luszczynska et al., 2013). Therefore, although findings from the current study suggest no direct association was observed between self-regulation and behaviour change, this does not mean this construct did not *indirectly* influence behaviour change. Mediation analyses are needed to explore how self-regulation and other individual, social, and environmental constructs *directly* and *indirectly* influence short- and long-term behaviour change.

Associations of participant characteristics with change in physical activity and dietary behaviour suggested those most responsive to the intervention were those who were: 1) not employed; 2) did not have endocrine treatment; and, 3) had finished treatment more than 12 months ago. Previous physical activity interventions in breast cancer survivors have reported some overlapping characteristics associated with better long-term physical activity, but these findings were not replicated in the current study (e.g., younger age and higher baseline physical activity; Courneya et al., 2007; Vallance et al., 2007). Participants who were unemployed in the current study may have simply had more time to commit to increasing physical activity, while participants who did not receive endocrine treatment may have experienced lower levels of joint pain and stiffness (commonly reported as a severe treatment side effect; Boonstra et al., 2013; Fallowfield et al., 2004). Time since the completion of treatment was associated with long-term dietary behaviour change, but not physical activity change. Previous studies have found that time since treatment predicts changes in physical activity (with longer time since treatment associated with greater increases in physical activity; Emery et al., 2009; Ganz et al., 2011), but the current study presents emerging evidence to suggest the importance of time since treatment in relation to long-term dietary change. Common treatment side effects such as nausea and fatigue may persist for up to one year post-treatment and may interfere with the adoption of new health behaviours, such as dietary behaviour change (Ganz et al., 2011).

The strong relationship between endocrine treatment and long-term physical activity, and time since treatment and energy intake, indicates these treatment-specific characteristics may be particularly useful screening indicators to apply in a clinical setting. With the exception of employment status, the lack of significant demographic findings is favourable and suggests program outcomes may be equitable across demographic groups. Additional strategies need to be considered to promote short- and long-term physical activity and dietary behaviour change for women who were least receptive to the program. This includes women who were employed, received endocrine treatment, and were less than 12-months post-treatment. Future research may explore discussing and providing more time management skills for those employed, and addressing common treatment-related side-effects related to fatigue, nausea, and joint pain, and modifying behavioural targets based on these.

There are a number of limitations in this study that should be considered. Due to lack of a control group, it was not possible to attribute change due to intervention effects. A small sample size also precluded a mediational analysis. Identifying the most appropriate measure to use for evaluating each theoretical construct was challenging due to heterogeneity in theories and methods used across studies. However, where possible, the current study used measures of theoretical constructs that were behaviourally-specific (e.g., self-efficacy for physical activity) and tailored to the breast cancer survivor population to increase the specificity and sensitivity of detecting real and meaningful change. Energy intake was chosen in this study to be the most comprehensive indicator of overall dietary behaviour change, particularly in the context of a weight loss intervention. However, it may be possible that different cognitive and behavioural processes are related to different dietary indicators (e.g., fat intake, diet quality, fruit and vegetable intake). The current findings may be limited to the overweight breast cancer survivor population, but given the lack of evidence to date, findings may help guide further research across a range of target groups.

7.13 Chapter summary

The overall objective of this study was to explore gaps in the literature related to the theoretical constructs and participant characteristics associated with short- and long-term physical activity and dietary behaviour change. This objective was achieved through the exploration of three key sub-objectives in the context of breast cancer survivors in the

Living Well after Breast Cancer feasibility trial: 1) to explore the theoretical constructs that were successfully targeted during the intervention; 2) to explore the constructs associated with short- and long-term physical activity and dietary behaviour change; and, 3) to identify the participant characteristics associated with favourable physical activity and dietary outcomes.

Findings suggested the importance of targeting self-efficacy to promote short- and long-term physical activity change, outcome expectancy and perceived environment to promote long-term physical activity change, and social support to promote short- and long-term dietary change. Participants who were not employed, did not receive endocrine treatment, and were more than 12-months post-treatment were most responsive to the intervention. Additional strategies may be needed to support short- and long-term physical activity and dietary behaviour change outcomes in participants who are employed, received endocrine treatment, and are within 12-months of completing treatment (e.g., time management skills, addressing treatment side effects).

Future research should further explore the objectives in this study but with larger sample sizes with increased statistical power to further evaluate the predictive and causal pathways between individual, social, and environmental theoretical constructs and behaviour change to better understand underlying mechanisms of behaviour change. Further implications and recommendations related to the design and development of behaviour change interventions promoting maintenance of behaviour change are considered in Chapter Eight.

CHAPTER 8

DISCUSSION

The aim of this thesis research was to contribute to the evidence on understanding and influencing the maintenance of physical activity and dietary behaviour change in breast cancer survivors. This chapter provides a summary of the formative findings that contributed to the development of the extended contact intervention (Chapters Three, Four, and Five) and elaborates on key findings from the intervention trial (Chapters Six and Seven). Specifically, results from the Living Well after Breast Cancer extended contact intervention will be integrated with the broader evidence to date to interpret their magnitude and pattern. This thesis research was conducted in a sample of breast cancer survivors where evidence on the maintenance of weight loss and related behaviour change is limited (Reeves et al., 2014; Spark et al., 2012), thus evidence from the broader (non-breast cancer populations) literature will be drawn upon to help put overall findings from this thesis research into a broader context. Limitations of this research will be reviewed, recommendations for future research proposed, and implications for practice to promote sustainable behaviour change discussed.

8.1 Summary of formative findings from this thesis research

8.1.1 Physical activity and/or dietary behaviour change interventions in breast cancer survivors: A review of the maintenance of outcomes (Chapter Three)

There are a growing number of randomised controlled trials supporting the efficacy of physical activity (Schmitz et al., 2005; Speck et al., 2010) and dietary (Chlebowski et al., 2006; Pierce et al., 2007b) behaviour change interventions in breast cancer survivors, but little is known about how to design such interventions to promote maintenance following the end of an intervention. We conducted a systematic review to determine the frequency with which physical activity and dietary maintenance outcomes are reported in interventions targeting breast cancer survivors, and the participant and intervention characteristics associated with successful maintenance outcomes. Findings suggested few studies report long-term outcomes at least three months following the end of an intervention, and few similarities were found across interventions due to the heterogeneity of studies. This evidence gap on reporting of maintenance outcomes is mirrored in the broader adult population literature (Fjeldsoe et al., 2011). Current evidence is thus limited

in its ability to inform the development of behaviour change interventions to promote maintenance in both breast cancer-specific and broader populations. One clear recommendation from the available evidence is that extending contact with participants following intensive intervention delivery is likely to improve long-term outcomes.

8.1.2 Feasibility and acceptability of a physical activity and dietary text message-delivered intervention in breast cancer survivors: SMS-4-Living Well pilot study (Chapter Four)

Text messaging is a potential cost-effective and broad reach modality to deliver the extended contact interventions that are needed to promote maintenance of behaviour change. There is evidence to support the efficacy of using text messaging to deliver short-term health behaviour change interventions (Fjeldsoe et al., 2012; Maddison et al., 2014; Spring et al., 2012; Whittaker et al., 2009), and emerging evidence to support the use of this modality to deliver extended contact interventions (Donaldson et al., 2014; Gerber et al., 2009). However, reviews exploring text message-delivered interventions report a focus on adolescents (Lau et al., 2011) and younger adults (Fjeldsoe et al., 2009; Spring et al., 2012). There is some evidence for the efficacy of text message-delivered interventions in older adults (Maddison et al., 2014), but there is scepticism regarding the acceptability of these interventions among older adults (Greaney et al., 2012). The aim of Chapter Two was to conduct a small pilot study to explore the acceptability and feasibility of sending text messages to breast cancer survivors (a primarily older population). To promote physical activity and dietary behaviour change in this study, eight participants (mean age = 49 years) received highly tailored text messages (median per fortnight = 18 texts) based on constructs and strategies associated with behaviour change. Participants reported high satisfaction with the text messages, and reported the messages were helpful to prompt behavioural cues and provide feedback on goal attainment. The findings from this pilot study informed the development of the Living Well after Breast Cancer extended contact intervention (described in detail in Chapter Five).

Formative research to design interventions is critical, particularly when employing novel ways to deliver behaviour change interventions such as mobile technology (Linde et al., 2014; Pfaeffli et al., 2012; Rogers et al., 2010; Waterlander et al., 2014; Whittaker et al., 2012). The iterative process required to conduct formative research is time consuming but, as outlined in mHealth (i.e., text message) intervention development frameworks, reporting

development processes can help design tailored and highly acceptable interventions (Waterlander et al., 2014; Whittaker et al., 2012). The findings from the pilot study informed an additional point of telephone contact during the extended contact intervention, and also highlighted the need to invest in custom-designed software to enable real-time feedback to be provided. This formative work was a particular strength of this thesis due to the lack of evidence to date to guide the development of a text message-delivered intervention in older adults (Rogers et al., 2010).

8.2 Summary of intervention findings from this thesis research

Chapter Six described an evaluation of the efficacy, feasibility, and acceptability of the Living Well after Breast Cancer text message-delivered extended contact intervention to promote maintenance of physical activity and dietary behaviour change in a sample of breast cancer survivors. Participants completed a six-month telephone delivered weight loss intervention (baseline to 6-months), received a six-month text message-delivered extended contact intervention (6- to 12-months), followed by a six-month period of no-contact (12- to 18-months). Mean participant age was found to be largely representative of the broader breast cancer survivor population in Australia, providing some support for the generalisability of findings.

8.2.1 Findings and implications on weight loss maintenance (Chapter Six)

In the 12-month period following the initial intervention, the average weight regain observed was 0.1kg per month, with a total regain of 23.5% of initial weight lost. The majority of weight regain occurred during the six-month extended contact intervention (average regain of 0.2kg per month), with minimal change observed during the six-month period of no contact (average mean weight loss of -0.01kg). The amount of weight regain observed in this trial is better than that reported in trials without extended intervention contact (0.3kg per month; regain 50 per cent of weight loss; Curioni et al., 2005; Dansinger et al., 2007), and comparable to the regain of 0.1 to 0.3kg commonly reported during longer-term ongoing interventions (Goodwin et al., 2014; Group et al., 2006; Wadden et al., 2011) and extended contact interventions (Harris et al., 2013; Harvey-Berino et al., 2004; Perri et al., 2008; Svetkey et al., 2008; Wing et al., 2006). Therefore, the current findings support the growing consensus that weight regain following the end of an initial

intensive intervention is expected, but that extended contact can help to attenuate the magnitude of regain (Jensen et al., 2014; Middleton et al., 2012).

Studies suggest that the magnitude of weight regain observed during extended contact interventions may be minimised when they are delivered via more intensive modalities such as face-to-face or telephone (0.1kg to 0.2kg per month) compared to less intensive delivery modalities such as internet or print (0.2 to 0.3kg per month; Harvey-Berino et al., 2002; Perri et al., 2008; Svetkey et al., 2008; Wing et al., 2006). Concordantly, findings from a recent meta-analysis reported extended contact interventions delivered via face-to-face or telephone resulted in approximately 3.2kg less weight regain over 18-months compared to control conditions (Middleton et al., 2012). However, this review did not include extended contact interventions delivered via other modalities such as print, internet or text messaging. Systematic reviews of internet-delivered extended contact interventions provide limited and mixed support for their efficacy in comparison to no-contact control or more intensive delivery conditions (Kodama et al., 2012; Neve et al., 2010), with regains of 0.3kg per month reported on average across internet-delivered extended contact intervention groups (Harvey-Berino et al., 2002; Svetkey et al., 2008; Wing et al., 2006).

Interestingly, one study to date has evaluated a text message-delivered extended contact intervention and reported additional *weight loss* of 0.5kg per month during the three-month extended contact intervention, which was following a three-month face-to-face weight loss intervention (Donaldson et al., 2014). Another study reported on a one-month text message-delivered behaviour change intervention provided to participants following a commercially available weight loss program and reported 87% of participants regained less than 3% of initial weight loss at three-months follow-up (Shaw et al., 2013). However, due to the short timeframes of both the initial and extended contact interventions in these two studies, the findings would appear to be more relevant to short-term weight loss (\leq six months) rather than long-term weight loss maintenance (\geq six months). Overall, limited evidence is available to compare the efficacy of extended contact interventions delivered via different modalities in promoting long-term weight loss maintenance. However, the magnitude of weight regain observed during the text message-delivered extended contact in the current study appears to be similar to that reported during face-to-face- or telephone-delivered extended contact, and better than outcomes from internet- or print-delivered extended contact.

Importantly, no extended contact interventions to date report outcomes following a period of no-contact to determine whether the attenuation of weight loss relapse observed during extended contact was sustained post-intervention. In the absence of such evidence, it would be expected that weight regain after an extended contact intervention would be in the magnitude of 0.3kg per month, which is observed in studies reporting long-term post-intervention weight loss outcomes (Dansinger et al., 2007). However, in contrast, the current study reported minimal changes in weight during the six-month no-contact post-intervention period (average mean weight loss of -0.01kg). The finding that weight loss was successfully maintained following a period of no-contact is promising given the limited evidence to date indicating how to promote weight loss maintenance long-term without the need for ongoing support (Jensen et al., 2014). The ongoing, day-to-day prompting of behaviours in 'real time' during the extended contact intervention may have helped to embed behaviours to become habitual such that they persisted even when prompting was removed (Gardner, 2014; Rothman et al., 2009).

8.2.2 Findings and implications on maintenance of behaviour change (Chapter Six)

Evidence from studies reporting long-term physical activity and dietary outcomes indicate initial behavioural improvements commonly decline immediately following the end of the initial intervention, even during periods of ongoing contact, and gradually worsen over time (Goodwin et al., 2014; Toobert et al., 2010). Some decline in physical activity and energy intake was therefore expected during the extended contact period in the current trial, with ongoing decline in these behaviours over time. However, results showed that after the initial intervention, physical activity declined during the extended contact intervention (-6.1 minutes per day) but then increased during the no-contact follow-up period (7.8 minutes per day) to be significantly higher at 18-months compared to baseline (10.4 minutes per day; $p = 0.003$). It was particularly positive and surprising that physical activity significantly improved following the no-contact period, especially given the reported difficulty in achieving long-term maintenance of physical activity post-intervention (Fjeldsoe et al., 2011; Greaves et al., 2011; Spark et al., 2012). One possibility is that participants may have responded to weight gain experienced during the extended contact intervention by increasing their physical activity (Apolzan et al., 2014).

In contrast, energy intake gradually and consistently increased during the extended contact intervention (364kJ per day) and no-contact period (416kJ per day) such that

effects were not significantly different to baseline at 18-months (-417kJ/day; $p = 0.200$). This finding supports existing evidence reporting the difficulty in maintaining improvements in dietary behaviour change long-term, especially without ongoing support (Christie, 2010; Jensen et al., 2014; Metzgar et al., 2014). Eating is an inherently social behaviour that is strongly influenced by social and environmental settings (Delormier et al., 2009). Extended contact via text message may therefore not be intensive enough to support long-term dietary behaviour change, and more intensive support may be required. This may include integrating text messaging with self-monitoring phone applications that can provide real-time contextual prompts and feedback, or enlisting greater support for ongoing behaviour change from family and friends.

Given the importance of both physical activity and dietary behaviours in influencing weight loss maintenance (Riebe et al., 2005), it would be expected that patterns of change in these behaviours would follow similar relapse-plateau patterns observed for weight. However, a similar pattern of change was observed for weight and physical activity but not for diet. Relapses in weight and physical activity were observed during the extended contact period but improved during the no-contact follow-up period, whilst energy intake continued to worsen over time. These findings support the importance of physical activity in particular for successful weight loss maintenance, as has been widely established in the weight loss maintenance literature (Catenacci et al., 2007; Jensen et al., 2014; Reiner et al., 2013). Emerging research also suggests the potentially protective effect of sequentially, rather than simultaneously, tailoring interventions to focus firstly on the habituation of physical activity before shifting to focus on dietary behaviours to promote the long-term maintenance of both behaviours (King et al., 2013). Collectively, the findings from this thesis research contribute to the evidence supporting the importance of focusing on promoting the maintenance of physical activity behaviour change to positively influence long-term weight loss maintenance and associated behaviours.

8.2.3 Findings and implications on underlying theoretical mechanisms of behaviour change maintenance (Chapter Seven)

There are a limited number of experimental studies determining the relative importance of theoretical constructs in the promotion of short- and long-term physical activity and dietary behaviour change (Van Stralen et al., 2009; Williams et al., 2008). Chapter Seven evaluated the theoretical constructs and participant characteristics associated with short-

and long-term physical activity and dietary behaviour change in participants who completed the Living Well after Breast Cancer extended contact intervention. Whilst participant characteristics specific to this study were identified and have importance for guiding the development of interventions for breast cancer survivors, the theoretical findings from this study have implications for the broader population and are discussed in more detail below.

Rothman and colleagues (2009) propose that initiation of new behaviours is dependent on constructs related to expectations and ability (i.e., outcome expectations, self-efficacy), while maintenance is dependent on the assessment of whether outcomes associated with the recently adopted behaviour are sufficiently satisfying to warrant continued action (i.e., satisfaction with outcomes). However, exploratory findings from Chapter Seven found self-efficacy was important for both short- and long-term change, outcome expectancy was associated with long-term change, and constructs external to the individual such as social and environmental constructs were important for both short- and long-term change. Importantly, satisfaction with outcomes was not associated with either short- or long-term physical activity or dietary behaviour change. Overall, these findings do not support the specific constructs proposed by Rothman and colleagues (2009) to be associated with short- or long-term behaviour change, but do support the importance of targeting individual, social, and environmental constructs as specified in the Ecological Model (Ding et al., 2012; Story et al., 2008). Future interventions need to focus on promoting constructs external to the individual to promote lasting change.

8.3 Limitations of findings from this thesis research

A number of limitations need to be considered in light of these thesis findings.

The extended contact intervention was not compared to a control group, thus outcomes could not be attributed as due to the intervention. However, the broader weight loss maintenance literature offered some guidance as to the patterns and relapse in weight and behaviours that were expected after an initial weight loss intervention in the absence of extended contact, allowing interpretation of intervention outcomes.

The sample size in the extended contact intervention was guided by the number of participants who completed the Living Well after Breast Cancer feasibility trial, and were eligible to participate in the extended contact intervention (n = 36). This small sample size

contributed to low statistical power, which restricted the types of analyses that were appropriate and may have contributed to errors in interpretation. Wide confidence intervals were particularly apparent for physical activity and dietary outcomes, and this may have increased the unreliability of findings and contributed to a lack of precision in detecting statistical significance and estimating mean effects sizes (Button et al., 2013; Christley, 2008). Specifically, wide confidence intervals around physical activity estimates may have increased the risk of type I errors (i.e., detected a significant finding when there was no real effect) or exaggerated the magnitude of a significant finding, while wide confidence intervals around estimates of energy intake may have increased the risk of type II errors (i.e., failed to detect a significant finding when there was a real effect). Adequately powered studies are needed to advance our understanding of maintenance of behaviour change.

This research explored maintenance in the context of a breast cancer survivor population, and while the age of this sample was reported to be largely representative of the breast cancer survivor population in Australia, findings may not be generalisable to the broader population of adults. Cancer survivors are often highly motivated to seek information to improve health and wellbeing following diagnosis (Basen-Engquist et al., 2012; Befort et al., 2011; Doyle et al., 2006), and breast cancer survivors have been characterised as particularly altruistic in wanting to help other survivors (Godskesen et al., 2014). Breast cancer survivors may therefore be particularly motivated, making comparisons in weight and behavioural improvements to that expected in the general population difficult. However, the breast cancer survivorship journey is similar to that of other cancer survivors (Duijts et al., 2014; Rowland et al., 2014), and older breast cancer survivors experience similar co-morbidities and decline in physical functioning associated with the general aging population (Fontein et al., 2013). Therefore although breast cancer survivors represent a specific target group, some comparisons can be made to other cancer survivor groups and the older general population.

Physical activity and dietary behaviour measurement error may have occurred. Objectively measured physical activity can overcome recall and social desirability biases associated with self-report methods, but can be associated with reactivity bias (Dyrstad et al., 2014; Motl et al., 2012). Over-estimates of physical activity may have occurred due to participants making deliberate efforts to engage in higher levels of activity than normal due

to the presence of the accelerometer. This may have influenced baseline measurement of physical activity, making it more difficult to detect significant changes in activity over time (Motl et al., 2012). Self-report dietary measures have been associated with significant under-reporting by nearly 40% of energy intake in overweight women (Lichtman et al., 1992; Poppitt et al., 1998; Raymond et al., 2012). Similarly, this measurement error may have contributed to lower estimates of dietary intake throughout, and contributed to the difficulty in understanding how patterns of energy intake influence weight loss maintenance. Further, energy intake was selected as a single comprehensive measure to assess diet, but it is important to consider that a range of dietary indicators important to diet quality may have changed throughout the study but were not evaluated here (e.g., fat intake, fruit and vegetable intake).

Finally, the complexity associated with assessing 'maintenance' of behaviour change is reflected in the literature (Seymour et al., 2010). Although there is some consensus for the use of a six-month time frame to signify maintenance, this timeframe is quite arbitrary, with less clarity about the definition and magnitude of behaviour change that indicates successful maintenance. It is also important to acknowledge the difficulty in correlating changes in physical activity and diet measured at a single point in time with more cumulative changes in weight. Assessing behaviour during a one week period and then inferring this pattern of behaviour has occurred over a six month period and trying to equate it with weight loss may have contributed in errors in interpretation. More sophisticated approaches to measurement, such as momentary data collection, may include more frequent and recurring assessments of behaviour that are more sensitive to detecting change (Marszalek et al., 2014).

8.4 Future directions for research

8.4.1 Extended contact interventions

Randomised trials are needed to determine comparative effectiveness and cost-effectiveness of extended contact intervention delivery modalities. The extended contact review by Middleton and colleagues (2012) only included studies delivered via face-to-face or telephone, and reviews of internet-delivered extended contact interventions report mixed findings in terms of efficacy of maintenance outcomes (Kodama et al., 2012; Neve et al., 2010). Systematic reviews indicate the effectiveness of short-term weight loss

interventions delivered via mobile technologies but limited research has explored long-term maintenance outcomes or cost-effectiveness compared to other mediated delivery modalities (Bacigalupo et al., 2013). One study is currently investigating the comparative and cost-effectiveness of a randomised 12-month extended contact intervention delivered via either group-based telephone counselling or newsletters following an initial six-month group-based telephone counselling intervention in a group of rural breast cancer survivors (Befort et al., 2014). Promisingly, this study also includes a six-month no-contact post-intervention period to evaluate maintenance of effects following the end of an extended contact intervention (Befort et al., 2014). Further randomised trials of extended contact intervention delivery modalities that include no-contact post-intervention periods are needed to evaluate comparative effectiveness and cost-effectiveness of different modalities to determine the efficacy in promoting maintenance during and after extended contact (e.g., face-to-face vs. phone vs. internet vs. text messaging vs. other mobile technologies).

Emerging evidence supports the use of exploring adaptive approaches to the delivery of long-term interventions to promote maintenance of successful weight loss and behaviour change outcomes (Adams et al., 2013; Almirall et al., 2014). An adaptive intervention is one that can continuously modify and tailor intervention duration, frequency, intensity, and modality based on an individual's ongoing needs (Almirall et al., 2014). Adaptive extended contact interventions may hold particular promise for preventing long-term weight regain as relapses in behaviour can be monitored and addressed immediately. For example, if weekly physical activity targets are not achieved, the frequency and/or intensity of contact may be temporarily increased to provide additional support until these behaviours are improved. Similarly, if weekly physical activity targets are achieved, the frequency and/or intensity of contact may be reduced. Adaptive treatment models and stepped-care approaches have been found to be effective in long-term physical activity (Adams et al., 2013) and weight loss interventions (Jakicic et al., 2012), and in studies addressing patterns of abstinence and relapse related to drug and alcohol dependence (Mckay, 2005). Further exploration of adaptive extended contact interventions, particularly those leveraging advances in technology enabling faster feedback loops, may inform highly tailored approaches to the frequency, intensity, dose and focus on physical activity and/or dietary behaviours to promote maintenance of long-term outcomes.

To further understand how extended contact interventions may best promote the maintenance of weight loss and behaviour change, future trials should rigorously explore the:

- effectiveness of extended contact interventions compared to no-contact control conditions;
- comparative effectiveness of extended contact intervention delivery modalities;
- cost-effectiveness of extended contact intervention delivery modalities
- reporting of outcomes following no-contact post-intervention periods after extended contact;
- adaptive models of extended contact intervention development and delivery

8.4.2 Text messaging

The use of text messages in behaviour change interventions has become prolific over the last decade. Systematic reviews provide strong evidence to support the efficacy of text message-delivered behaviour change interventions to promote the *initiation* of weight loss and physical activity and dietary behaviour change (Fjeldsoe et al., 2009; Johnston et al., 2014; O'reilly et al., 2013; Shaw et al., 2012; Siopis et al., 2014). In conjunction with findings presented in this thesis, there is now emerging evidence to support the feasibility, acceptability, and efficacy of text message-delivered extended contact interventions to promote the *maintenance* of weight loss and associated behaviour change (Donaldson et al., 2014; Fjeldsoe et al., 2014; Gerber et al., 2009; Shaw et al., 2013). However, this research is in its infancy and there is a need to further explore acceptability of text messaging across different ages and populations as preference for communication modality can influence satisfaction and intervention outcomes (Beall, 2014).

Feasibility findings from this thesis research suggest the need for more sophisticated approaches to delivering text message extended contact interventions to allow a higher level of automation to reduce researcher burden. Such advances in programming and software development may be derived from current gaming and mobile phone applications which are designed to be largely automated while being highly responsive to a wide range of highly tailored participant variables (e.g., able to tailor individual feedback based on participant's past success or failures). In addition, efforts should be made to explore the efficacy of integrating text messaging with other mobile technologies (Klasnja et al., 2012). Opportunities may include integrating self-monitoring applications (e.g., photos of food

portions, electronic food diaries) with text message feedback, and also exploring how the availability of contextual information related to behaviour and environment (e.g., GPS accelerometers) can help provide further tailored opportunities for text message prompts.

However, satisfaction findings from the current research highlight the importance of a text message-delivered intervention maintaining some element of 'human' connection to foster a sense of ongoing accountability. Future iterations of text message-delivered interventions therefore need to consider balancing more sophisticated intervention delivery with occasional contact via more 'humanised' or more conventional communication channels (e.g., telephone or email). While there is some evidence to suggest changing or integrating different mediated intervention delivery modalities may negatively influence maintenance outcomes (Harris et al., 2013), there is support for the efficacy of combined technology-based intervention delivery compared to single delivery modalities (Klasnja et al., 2012). Integrating text messaging during the initial phase of an intervention, such as in combination with telephone contact, which is then continued during an extended contact intervention may negate negative effects reported with the introduction of a new delivery modality (Harris et al., 2013). Future research therefore needs to explore the integration of text messaging, during both initial and extended contact interventions, with both conventional and novel delivery modalities to inform evidence-based practice (Free et al., 2013).

The optimal dose of support to provide during an extended contact intervention is also unclear, and likely to be different for each individual (Greaves et al., 2011). Determining significant dose-response relationships between text message dose and behavioural outcomes can inform the development of future extended contact interventions. Every additional text message received per week in this study was associated with a mean increase of more than one hour of physical activity per week at follow-up. The lack of findings to support a dose-response relationship between text messages and diet provides further indication that more intensive support may be required to promote long-term dietary outcomes. The contextual prompting and cues to action provided by text messaging may be most suited to supporting more discrete and habitual behaviours like physical activity which is most often a once-per-day occurrence. Alternatively, dietary behaviour change is inherently more complex and involves ongoing reflective and automatic decision making processes multiple times per day (Rothman et al., 2009). Support for long-term dietary

behaviour change may therefore need to be more inclusive of contextual social and environmental cues as evidenced in Chapter Seven, and the integration of text messaging with more advanced tools such as mobile phone applications to provide contextually appropriate support may be important. Overall, further evidence on the minimum dose required to promote maintained improvements in different behaviours needs to be determined (Greaves et al., 2011).

To further explore the utility of text messaging in behaviour change interventions, future research needs to consider:

- exploring the acceptability of the text-message intervention delivery modality among different populations, including men and healthy-weight women
- integrating technology from mobile phone applications to increase intervention delivery automation and reduce researcher burden;
- including additional (and potentially 'opt-in') check-in contacts delivered via telephone or email to ensure participant satisfaction and accountability;
- exploring effects of integrating text messaging with other mediated delivery modalities during initial and extended contact phases (e.g., telephone, internet, email);
- determining dose-response relationships to inform minimum dose of messages required to positively influence behaviour change.

8.4.3 Theoretical mechanisms of behaviour change

While the results of this research and others suggest different constructs may be associated with the initiation or maintenance of physical activity and dietary behaviour change (Rothman et al., 2009; Van Stralen et al., 2009; Van Stralen et al., 2010; Williams et al., 2008), no rigorous evidence to date has determined the relative importance of specific constructs to either the initiation or maintenance of behaviour change. Further research needs to rigorously evaluate through mediational analyses how changes in interpersonal, social, and environmental constructs directly (and indirectly) influence behaviour change. These findings would guide intervention development in targeting specific constructs in different phases of an intervention (e.g., initial vs. extended contact phases) to promote the best short- and long-term outcomes.

Given the growing importance of this research in informing evidence-based development of behaviour change interventions, further research could:

- pool findings across studies that report on change in constructs associated with change in behaviour (i.e., predictors or mediational analyses) to provide adequate power to examine the constructs important for initiation and maintenance;
- apply Rothman's framework in individual studies using mediational analyses to explore differences in the importance of constructs related specifically to the initiation and maintenance of behaviour change;
- explore a broad range of different types of constructs to comprehensively assess influences from various determinants (e.g., psychological, social, environmental);
- compare differences in the constructs important for initiation or maintenance across physical activity and dietary behaviours to inform intervention content for specific behaviours.

8.5 Implications for practice

The findings from this thesis research have implications for the delivery of weight loss interventions for the broader adult population, and particularly those that cease intervention contact after short-term interventions (i.e. six-months). The Get Healthy Information and Coaching Service (GHS) is a free, publically available, telephone-delivered intervention targeting moderate weight loss through improved physical activity and dietary behaviours in Australian adults (O'Hara et al., 2013). The GHS provided an ideal platform to explore a text message-delivered extended contact intervention to promote maintenance of weight loss and behaviour change in the broader adult population. The Get Healthy, Stay Healthy (GSHS) trial randomised participants who completed the initial six-month telephone-delivered intervention to either a six-month tailored text message-delivered intervention or no contact control group (Fjeldsoe et al., 2014). The GSHS extended contact intervention was modified from the Living Well after Breast Cancer extended contact intervention. Preliminary findings from the GSHS trial indicate that participants who received the extended contact intervention had significantly better weight loss and behavioural outcomes at 12-months compared with participants in the control group (Fjeldsoe, 2014). Together, findings from this thesis research and the GSHS trial support the efficacy for lifestyle modification interventions to extend contact

with patients after the end of an initial intervention, and that text messaging may be an effective delivery modality to provide extended contact.

Lastly, findings from this thesis research have the potential to influence the access and availability of mediated lifestyle interventions in Australia. Public and private health rebates are not currently available for patients in Australia who access telephone-delivered care. The availability of telephone-delivered services are particularly critical for people who live in rural or remote areas, face considerable mobility or disability barriers, live in socio-economically disadvantaged areas with higher rates of chronic disease and inadequate number of health professionals, and people in low income brackets who are less likely to be able to access and afford face-to-face support. Findings from this PhD research support the potential for telephone-delivered and text message-delivered interventions to provide effective lifestyle support to the broader Australian population. The implications of the findings strongly encourage addressing gaps in policy and legislation around the provision of health care in Australia to provide equitable healthcare services to all Australians.

8.6 Conclusion

Maintaining improvements in physical activity and dietary behaviour is challenging. Despite the importance of interventions promoting long-term behaviour change, little attention has been directed towards understanding how to design behaviour change interventions to promote successful maintenance outcomes. Responsive to this, this thesis aimed to improve our understanding of how to influence the maintenance of physical activity and dietary behaviour change, and explored the efficacy of a text message-delivered extended contact intervention following an initial telephone-delivered weight loss intervention in breast cancer survivors.

Firstly, a systematic review of the physical activity and dietary behaviour change intervention literature in breast cancer survivors mirrored findings from the broader literature, and identified the need to focus on reporting of long-term outcomes after the end of an initial behaviour change intervention to advance our understanding of how to design behaviour change interventions to promote successful maintenance. Secondly, evaluation of a text message-delivered extended contact intervention supported the acceptability, feasibility, and efficacy of this intervention in promoting successful maintenance of weight

loss and physical activity behaviour change outcomes. Lastly, exploring the underlying behaviour change mechanisms following the extended contact intervention identified specific individual, social, and environmental constructs associated with short- and long-term physical activity and dietary behaviour change.

Together, findings from this thesis contribute to the evidence supporting the efficacy of text messaging as a behaviour change intervention delivery modality, and also further our understanding of how extended contact interventions may support the maintenance of weight loss and behaviour change. As technology in healthcare rapidly advances, understanding the intervention characteristics and theoretical mechanisms that drive the maintenance of behaviour change can inform the development of novel, innovative, and effective broad-reach interventions to promote lasting health behaviour change among the greater population.

CHAPTER 9

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Appendix 7.D: Mean standardised changes in physical activity-related constructs from baseline and between the follow-up timepoints

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Appendix 7.F: Overall associations and timepoint interactions of changes from baseline in physical activity-related constructs with changes in physical activity, and differences in these associations between the follow-up timepoints

Appendix 7.G: Overall associations and timepoint interactions of changes from baseline in diet-related constructs with changes in energy intake, and differences in these associations between the follow-up timepoints

Appendix 7.H: Overall associations and timepoint interactions of baseline demographic and health-related characteristics with changes in physical activity, and differences in these associations between the follow-up timepoints

Appendix 7.I: Overall associations and timepoint interactions of baseline demographic and health-related characteristics with changes in energy intake, and differences in these associations between the follow-up timepoints

Appendix 2.A: Theoretical constructs associated with short- and/or long-term physical activity and/or dietary behaviour change

Construct	Definition	Short-term change (initiation)	Long-term change (maintenance)
Self-regulation	Group of strategies used to develop, implement, and maintain behaviours in order to achieve a goal (e.g., self-monitoring, goal setting, planning, self-reward, problem solving, and relapse prevention; Bandura, 1986)	Rhodes et al., 2010; Sniehotta et al., 2006; Spahn et al., 2010; Van Stralen et al., 2009	Anderson et al., 2010; Bock et al., 2001; Nigg et al., 2008; Thoolen et al., 2009; Vallance et al., 2010; Van Stralen et al., 2009
Self-efficacy	Individual's belief in their ability to perform a specific behaviour and succeed in challenging situations (Bandura, 1986)	Anderson et al., 2001; Courneya et al., 2004; Mcauley et al., 1994; Rothman et al., 2009; Sallis et al., 1992; Short et al., 2013; Van Stralen et al., 2009	Anderson et al., 2010; Bock et al., 2001; Crain et al., 2010; Nigg et al., 2008; Sallis et al., 1992; Vallance et al., 2010; Van Stralen et al., 2009; Williams et al., 2008
Social support	Individual's perceived support for engaging in target behaviour from important others, such as family and friends (Anderson et al., 2010)	Boutelle et al., 2004; Sallis et al., 1992; Spahn et al., 2010; Van Stralen et al., 2009	Anderson et al., 2010; Emery et al., 2009; Mcauley et al., 2003
Enjoyment (PA)	Individual's evaluation of how much they positively associate the act of engaging in, and continued involvement in, physical activity behaviours (Crain et al., 2010)	Mcauley et al., 2003	Crain et al., 2010; Mcauley et al., 2003
Perceived environmental opportunity	Individual's perceived availability of opportunities to engage in the the behaviour in the physical environment (Bandura, 1986)	Morris et al., 2008; Sallis et al., 1992; Short et al., 2013; Van Stralen et al., 2009; Williams et al., 2008	Van Stralen et al., 2009
Outcome expectancy	Individual's anticipated positive and negative expectations about the consequences of an action (Bandura, 1986)	Anderson et al., 2001; Courneya et al., 2004; Damush et al., 2001; Rothman et al., 2009; Short et al., 2013; Van Stralen et al., 2009	-
Satisfaction with outcomes	Individual's assessments of the experiences afforded by the new pattern of behaviour and evaluations of whether those outcomes are sufficiently satisfying to warrant continued action (Rothman et al., 2009)	-	Rothman et al., 2009; Van Stralen et al., 2009; Williams et al., 2008

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Appendix 3.A: Electronic supplementary material one forming part of published manuscript 'Physical activity and/or dietary interventions in breast cancer survivors: A systematic review of the maintenance of outcomes'

Title: Physical activity and/or dietary interventions in breast cancer survivors: A systematic review of the maintenance of outcomes

Journal: Journal of Cancer Survivorship

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Online Resource 1: Publication details; sample, intervention and methodological characteristics; and behavioral outcomes of intervention trials targeting physical activity and/or dietary behavior change in breast cancer survivors (n=10)

First author, year, country (Type of behaviour)	Sample Characteristics	Intervention Characteristics	Trial Methods	Intervention (Ix) Outcomes: Baseline; End-of-Ix; Follow-up	Between Groups Effects: p value end-of-Ix; Follow-up
Cantarero- Villanueva, 2012*[31] Spain (PA)	Group(n): Ix(38); C(40) Sample: Breast cancer survivors (100%) post- treatment Mean time since treatment: Majority <6m Mean age: 49.0yrs Mean BMI: NR Recruitment: Hospital	Theory: NR Duration: 6wk Delivery: 24 face-to-face supervised individual exercise sessions Strategies: 3 described (1, 21, 22) Maintenance strategies: 1 described & could not be coded in taxonomy (i.e., intervention participants received instructional DVD including exercise progression at end-of- intervention to maintain & promote healthy lifestyle)	Contact: Usual care PA measure: Trunk curl static endurance test; multiple sit-to- stand test End-of-Ix: 6wk (Ix 84%; C 88% retention) Post-Ix follow-up: 4m (NR) Methodological Quality Score: 4 (1, 2, 7, 10)	Trunk curl & sit-to-stand test: NR	Trunk curl: NR (d): 0.89, 95% CI 0.71-1.19; 0.21, 95% CI 0.20-0.47 Maintenance achieved: Yes Sit-to-stand: NR (d): 0.96, 95% CI 0.71-1.20; 0.50, 95% CI 0.27-0.90 Maintenance achieved: Yes
Daley, 2004; 2007 [48, 29] UK (PA)	Group(n): Ix(34); C(38) Sample: Breast cancer survivors	Theory: TTM & TPB Duration: 2m Delivery: 24 face-to-face	Contact: Usual care PA measure: Aerobic fitness using submaximal, 8-minute single-stage walking test	Aerobic fitness (mL/kg/min): NR	Aerobic fitness (mL/kg/min): 0.002; 0.583 Maintenance achieved: No

PA= physical activity; Ix= intervention; C= control; m= month; wk= week; mins= minutes; ns= not significant; d= effect size; NR= not reported; F&V= fruit and vegetables; TTM= Transtheoretical Model; SCT= Social Cognitive Theory; TPB= Theory Planned Behaviour; NEP= nutrition education program; COM= combined print and pedometer group; SR= standard recommendation group; *= successful maintenance achieved

	<p>(100%) post-treatment</p> <p>Mean time since treatment: 17.6m</p> <p>Mean age: 51.6yrs</p> <p>Mean BMI: 28.5 kg/m²</p> <p>Recruitment: Hospital registries; public advertising</p>	<p>supervised individual exercise & counseling sessions (3/wk)</p> <p>Strategies: 14 described (1, 2, 5, 8, 10, 13, 16, 18, 20, 21, 22, 23, 29, 35)</p> <p>Maintenance strategies: 1 described and coded as #35 in taxonomy (i.e., ‘avoiding relapse’ discussed in weeks 7-8)</p>	<p>performed on a treadmill (mL/kg/min)</p> <p>End-of-Ix: 2m (Ix 97%; C 87% retention)</p> <p>Post-Ix follow-up: 4m (Ix 94%; C 94% retention)</p> <p>Methodological Quality Score: 6 (2, 3, 6, 7, 9, 10)</p>		
<p>Demark-Wahnefried, 2003; 2006 [49, 37] USA (PA and Diet)</p> <p>Clutter Snyder 2007 [50] (Diet follow-up)</p>	<p>Group(n): Ix(89); C(93)</p> <p>Sample: Breast (57%) and prostate (43%) cancer survivors post-treatment</p> <p>Mean time since diagnosis: 11.1m</p> <p>Mean age: 71.5yrs</p> <p>Mean BMI: 27.3 kg/m²</p> <p>Recruitment:</p>	<p>Theory: SCT & TTM</p> <p>Duration: 6m</p> <p>Delivery: 12 telephone calls (1/fortnight) throughout; mailed tailored workbook at beginning intervention</p> <p>Strategies: 7 described (1, 5, 12, 16, 19, 21, 22)</p>	<p>Contact: Matched frequency & delivery mode as Ix group; Provided with general health counseling and print materials (not tailored; unrelated to PA & diet)</p> <p>PA measure: CHAMPS energy expenditure (k/cal/week)</p> <p>Dietary measure: Dietary Quality Index Revised (DQI-R) from 3-day dietary recalls; % eating total fat ≤ 10% energy intake; % eating saturated fat ≤ 10% energy intake; % eating cholesterol ≤ 300 mg/day; % eating 2-4 servings fruit; % eating 3-5 serves</p>	<p>PA energy expenditure (k/cal/week) mean (SD): Ix: 1882 (1916); 1993 (1670); 1557 (1534) C: 2104 (1735); 1704 (1402); 2024 (2047)</p> <p>DQI-R mean (SD): Ix: 67.6 (12.2); 69.8 (13.9); 67.5 (13.6) C: 67.5 (12.5); 64.6 (14.7); 66.6 (13.1)</p> <p>Total fat % mean (SD): Ix: 6.4 (3.1); 7.2 (3.2); 6.6 (3.2) C: 6.2 (3.4); 6.7 (3.2); 6.3 (3.4)</p> <p>Saturated fat % mean (SD):</p>	<p>PA energy expenditure: 0.13; 0.11</p> <p>Maintenance achieved: No</p> <p>DQI-R mean: 0.003; 0.19</p> <p>Maintenance achieved: No</p> <p>Total fat: 0.28; 0.32</p> <p>Maintenance achieved: No</p> <p>Saturated fat: 0.17; 0.59</p> <p>Maintenance achieved: No</p> <p>Cholesterol: 0.52; 0.73</p> <p>Maintenance achieved: No</p> <p>Fruit: 0.29; 0.96</p>

PA= physical activity; Ix= intervention; C= control; m= month; wk= week; mins= minutes; ns= not significant; d= effect size; NR= not reported; F&V= fruit and vegetables; TTM= Transtheoretical Model; SCT= Social Cognitive Theory; TPB= Theory Planned Behaviour; NEP= nutrition education program; COM= combined print and pedometer group; SR= standard recommendation group; *= successful maintenance achieved

Hospital registries	<p>vegetables; % eating 6-11 serves grains; calcium % adequate intake for age; iron intake % for age; dietary diversity (includes 23 food subgroups); dietary moderation (includes added sugar, sodium, alcohol)</p> <p>End-of-Ix: 6m (Ix 92%; C 92% retention)</p> <p>Post-Ix follow-up: 6m (Ix 87%; C 89% retention)</p> <p>Methodological Quality Score: 6 (1, 2, 3, 5, 7, 9)</p>	<p>Ix: 6.5 (3.1); 7.4 (3.4); 7.0 (3.6) C: 6.6 (3.7); 7.0 (3.4); 6.7 (3.4)</p> <p>Cholesterol % mean (SD): Ix: 8.5 (3.3); 9.2 (2.3); 9.0 (2.7) C: 8.9 (2.7); 8.8 (2.6); 8.7 (2.4)</p> <p>Fruit % mean (SD): Ix: 6.0 (3.2); 5.9 (3.6); 5.2 (3.4) C: 6.0 (3.5); 5.3 (3.5); 5.3 (3.4)</p> <p>Vegetable % mean (SD): Ix: 6.4 (2.9); 6.3 (2.8); 6.4 (2.6) C: 6.2 (2.9); 5.5 (2.8); 6.1 (2.8)</p> <p>Grains % mean (SD): Ix: 5.9 (2.3); 5.7 (1.9); 6.0 (2.1) C: 6.1 (2.2); 5.4 (2.3); 5.7 (2.3)</p> <p>Calcium % mean (SD): Ix: 7.0 (2.8); 7.1 (2.7); 6.8 (2.9) C: 6.6 (2.8); 6.1 (3.0); 6.9 (2.8)</p> <p>Iron% mean (SD): Ix: 8.9 (1.7); 9.0 (1.7); 8.9 (1.5) C: 9.0 (1.6); 8.6 (1.9); 9.1 (1.7)</p> <p>Dietary diversity mean (SD): Ix: 4.8 (1.3); 4.8 (1.4); 4.6 (1.3) C: 4.7 (1.2); 4.1 (1.1); 4.6 (1.2)</p> <p>Dietary moderation mean (SD): Ix: 7.2 (1.1); 7.4 (1.0); 7.0 (1.4) C: 7.1 (1.1); 7.2 (1.3); 7.3 (1.2)</p>	<p>Maintenance achieved: No</p> <p>Vegetable: 0.27; 0.17</p> <p>Maintenance achieved: No</p> <p>Grains: 0.33; 0.39</p> <p>Maintenance achieved: No</p> <p>Calcium: 0.07; 0.03</p> <p>Maintenance achieved: No</p> <p>Iron: 0.21; 0.09</p> <p>Maintenance achieved: No</p> <p>Dietary diversity: 0.001; 0.01</p> <p>Maintenance achieved: Yes</p> <p>Dietary moderation: 0.72; 0.93</p> <p>Maintenance achieved: No</p>
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PA= physical activity; Ix= intervention; C= control; m= month; wk= week; mins= minutes; ns= not significant; *d*= effect size; NR= not reported; F&V= fruit and vegetables; TTM= Transtheoretical Model; SCT= Social Cognitive Theory; TPB= Theory Planned Behaviour; NEP= nutrition education program; COM= combined print and pedometer group; SR= standard recommendation group; *= successful maintenance achieved

Demark-Wahnefried, 2003, 2007* [51, 36]] USA (PA and Diet) Ottenbacher, 2012 [52] (PA follow-up) Christy, 2011[53] (Diet follow-up)	Group(n): Ix(271); C(272) Sample: Breast (59%) and prostate cancer (41%) survivors post-treatment Mean time since diagnosis: 3.8m Mean age: 57.0yrs Mean BMI: 27.3kg/m ² Recruitment: Cancer registry	Theory: SCT and TTM Duration: 10m Delivery: Mailed tailored print materials; received two workbooks throughout & a series of 7 newsletters at 6wk intervals Strategies: 10 described (1, 2, 5, 8, 9, 10, 12, 13, 16, 19)	Contact: Mailed non-tailored print materials (workbook and newsletters) PA measure: 7-day PA recall MVPA mins/wk Diet measure: Diet history questionnaire: F&V serves/day; % calories from fat; % calories from saturated fat; Diet Quality Index Revised score (DQI-R) End-of-Ix: 12m (Ix 94%; C 98% retention) Post-Ix follow-up: 12m (Ix 87%; C 93% retention) Methodological Quality Score: 6 (1, 2, 3, 5, 7, 9)	MVPA mins/wk median (IQR): Ix: 0 (45); 90 (180); 60 (180) C: 0 (12); 30 (111); 30 (150) F&V serves/day mean (SD): Ix: 5.1 (2.7); 6.1 (2.8); 6.0 (2.7) C: 5.0 (2.3); 5.6 (2.5); 5.7 (2.8) % calories from fat mean (SD): Ix: 38.0 (5.7); 33.6 (5.8); 36.5 (6.6) C: 37.8 (5.6); 35.7 (4.6); 38.0 (5.4) % calories from saturated fat mean (SD): Ix: 11.1 (2.1); 9.8 (2.3); 10.0 (2.1) C: 11.1 (2.0); 10.7 (2.2); 10.7 (2.1) DQI-R mean (SD): Ix: 6.6 (11.1); 72.8 (10.6); 71.5 (10.5) C: 67.0 (9.4); 69.1 (10.8); 68.9 (10.6)	MVPA mins/wk: <0.01; 0.08 Maintenance achieved: No F&V: 0.014; 0.152 Maintenance achieved: No Fat: <0.001; 0.001 Maintenance achieved: Yes Saturated fat: <0.001; <0.001 Maintenance achieved: Yes DQI-R: <0.001; <0.001 Maintenance achieved: Yes
Hebert, 2001 [28] USA (DIET)	Group(n): Ix NEP(50); C(56) Sample: Breast cancer survivors (100%) post-treatment Mean time since diagnosis: 11.0m	Theory: SCT Duration: 4m Delivery: 2 individual face-to-face sessions at beginning & end of Ix; 15 group face-to-face sessions (1/wk) Strategies: 4 described (2, 21, 22, 29)	Contact: Monitored for individual behavior change through monthly telephone calls but received no formal intervention Diet measure: 7-day diet recall (7DDR): Total energy intake (kcal/day); dietary intake of fat (% energy); complex carbohydrates (g/day); dietary fiber (g/day) End-of-Ix: 4m (Ix 90%; C 96%)	Total energy intake (kcal/day) mean (SD) for baseline; mean change (SE) for end-of-intervention and follow-up: Ix: 1911 (674); -74.8 (74.1); -33.9 (79.2) C: 1727 (568); 16.7 (68.4); 21.5 (78.7) Dietary intake of fat (% energy) mean (SD) for baseline; mean	Total energy intake: ns; ns Maintenance achieved: No Fat: <0.05; <0.05 Maintenance achieved: Yes Complex carbohydrates: <0.05; ns Maintenance achieved: No Fiber: <0.05; ns

PA= physical activity; Ix= intervention; C= control; m= month; wk= week; mins= minutes; ns= not significant; d= effect size; NR= not reported; F&V= fruit and vegetables; TTM= Transtheoretical Model; SCT= Social Cognitive Theory; TPB= Theory Planned Behaviour; NEP= nutrition education program; COM= combined print and pedometer group; SR= standard recommendation group; *= successful maintenance achieved

	Mean age: 50.0yrs Mean BMI: NR Recruitment: Hospital & clinics	retention) Post-Ix follow-up: 8m (Ix 98%; C 89% retention) Methodological Quality Score: 7 (2, 3, 5, 6, 7, 8, 9)	change (SE) for end-of-intervention and follow-up: Ix: 34.0 (8.6); -5.8 (1.1); -4.1 (1.1) C: 33.9 (8.6); 0.2 (1.1); -0.3 (1.0) Complex carbohydrates (g/day) mean (SD) for baseline; mean change (SE) for end-of-intervention and follow-up: Ix: 112.0 (53.4); 9.8 (5.7); 7.8 (5.5) C: 103.8 (42.2); -6.0 (5.2); 2.6 (5.5) Dietary fiber (g/day) mean (SD) for baseline; mean change (SE) for end-of-intervention and follow-up: Ix: 14.5 (7.2); 2.0 (0.8); 1.6 (0.7) C: 13.4 (5.3); -0.2 (0.7); 0.3 (0.7)	Maintenance achieved: No	
Mustian, 2009* [32] USA (PA)	Group(n): Ix(19); C(19) Sample: Breast (71%) and prostate cancer (29%) survivors undergoing treatment Mean time since diagnosis: NR Mean age:	Theory: NR Duration: 1m Delivery: Introductory face-to-face session; instructional print materials to promote physical activity in home-based patient-selected environment Strategies: 5 described (5, 9, 16, 19, 21)	Contact: Instructed not to begin any new formal physical activity program; Completed physical activity diaries and were monitored by staff throughout intervention PA measure: DSW (steps walked/day); MRE (mins/day of resistance exercise); RED (number resistance exercise days/wk); AER (aerobic 6-minute walk test, ft); STR (strength	DSW mean (SD): Ix: 7222.2 (2691.3); 11,200.1 (5851.8); 12,878 (7570.1) C: 5544.9 (2746.7); 4796.9 (2613.9); 5180.8 (3258.9) MRE mean (SD): Ix: 1.16 (2.95); 10.59 (11.37); 8.00 (10.26) C: 1.57 (4.73); 0.00 (0.00); 0.73 (3.03) RED mean (SD): Ix: 0.21 (0.54); 3.26 (2.92); 1.56	DSW: <0.05; <0.05 Maintenance achieved: Yes MRE: <0.05; <0.05 Maintenance achieved: Yes RED: <0.05; <0.05 Maintenance achieved: Yes AER: ns; ns Maintenance achieved: No STR: ns; ns

PA= physical activity; Ix= intervention; C= control; m= month; wk= week; mins= minutes; ns= not significant; d= effect size; NR= not reported; F&V= fruit and vegetables; TTM= Transtheoretical Model; SCT= Social Cognitive Theory; TPB= Theory Planned Behaviour; NEP= nutrition education program; COM= combined print and pedometer group; SR= standard recommendation group; *= successful maintenance achieved

	60.0yrs Mean BMI: 30.0kg/m ² Recruitment: Doctor and nurse referrals		handgrip dynamometer) End-of-Ix: 1m (Ix and C 100% retention) Post-Ix follow-up: 3m (Ix and C 100% retention) Methodological Quality Score: 5 (1, 2, 3, 6, 9)	(2.50) C: 0.21 (0.63); 0.00 (0.00); 0.12 (0.49) AER mean (SD): Ix: 1894.37 (296.78); 1937.95 (261.99); 2020.59 (386.36) C: 1478.21 (401.02); 1425.28 (438.27); 1600.33 (468.86) STR mean (SD): Ix: 26.02 (7.16); 25.49 (7.29); 26.89 (8.71) C: 24.92 (7.89); 24.12 (8.74); 23.87 (7.79)	Maintenance achieved: No
Mutrie, 2007* [33] Scotland (PA)	Group(n): Ix(99); C(102) Sample: Breast cancer survivors (100%) undergoing treatment Mean time since diagnosis: 5.4m Mean age: 51.6yrs Mean BMI: 27.4kg/m ² Recruitment:	Theory: TTM Duration: 3m Delivery: 24 face-to-face supervised group exercise sessions (2/wk) with 12 additional independent home sessions Strategies: 4 described (1, 5, 21, 22) Maintenance strategies: 1 described & could not be coded in taxonomy (i.e., intervention participants helped to construct individual exercise program	Contact: Usual care PA measure: 7-day PA recall (Scottish leisure physical activity questionnaire – SPAQ); 12 minute walk test (meters) End-of-Ix: 3m (Ix 81%; C 90% retention) Post-Ix follow-up: 6m (Ix 81%; C 93% retention) Methodological Quality Score: 9 (1, 2, 3, 4, 5, 7, 8, 9, 10)	PA mins/wk mean (SD): Ix: 367 (306); 585 (385); 492 (327) C: 365 (288); 416 (405); 427 (370) 12min walk test (meters) mean (SD): Ix: 997 (211); 1135 (143); 1127 (166) C: 975 (235); 984 (224); 1013 (190)	PA mins/wk: 0.0009; 0.23 Maintenance achieved: No 12min test: <0.0001; <0.0001 Maintenance achieved: Yes

PA= physical activity; Ix= intervention; C= control; m= month; wk= week; mins= minutes; ns= not significant; d= effect size; NR= not reported; F&V= fruit and vegetables; TTM= Transtheoretical Model; SCT= Social Cognitive Theory; TPB= Theory Planned Behaviour; NEP= nutrition education program; COM= combined print and pedometer group; SR= standard recommendation group; *= successful maintenance achieved

Out-patient clinics at end-of-intervention)					
Pinto, 2005; 2008 [34, 54] USA (PA)	Group(n): Ix(43); C(43) Sample: Breast cancer survivors (100%) post-treatment Mean time since diagnosis: 1.74m Mean age: 53.4yrs Mean BMI: 27.5 kg/m ² Recruitment: Hospital, private oncology clinic; workplace mailouts	Theory: TTM Duration: 6m Delivery: Introductory face-to-face session; weekly telephone calls for months 1-3; monthly telephone calls for months 3-6 Strategies: 9 (1, 5, 8, 9, 12, 16, 19, 21, 27) Maintenance strategies: 1 described and coded as #27 in taxonomy (i.e., tapering of intervention contact from weekly to monthly to prompt & reinforce regular physical activity)	Contact: Asked not to change PA; received weekly telephone calls for months 1-3 to complete questionnaire (no delivery of intervention content) PA measure: 7-day recall moderate-intensity PA (MPA) recall mins/wk; one-mile walk test (minutes); total energy expenditure/wk (kcal/kg/wk); MPA energy expenditure/wk (kcal/kg/wk). End-of-Ix: 6m (Ix 91%; C 95% retention) Post-Ix follow-up: 3m (Ix 91%; C 93% retention) Methodological Quality Score: 6 (2, 3, 6, 7, 9, 10)	MPA mins/wk mean (SD/SE): Ix: 76.12 (86.96); 120.95 (34.34); 161.24 (27.50) C: 58.78 (77.97); 108.59 (32.55); 85.40 (26.07) Walk test mins mean (SD): Ix: 17.45 (2.05); 16.79 (0.26); 16.80 (0.27) C: 17.65 (2.00); 17.71 (0.24); 17.54 (0.25) Total energy expenditure/wk (kcal/kg/wk) mean (SD): Ix: 243.64 (18.52); 267.86 (5.85); 265.87 (6.23) C: 244.12 (20.18); 256.06 (5.53); 247.98 (5.89) MPA energy expenditure/wk (kcal/kg/wk) mean (SD): Ix: 5.07 (5.80); 5.51 (2.66); 9.66 (1.84) C: 3.92 (5.20); 6.54 (2.51); 4.31 (1.74)	MPA mins/wk: 0.765; 0.024 Maintenance achieved: No Walk test mins: 0.004; 0.023 Maintenance achieved: Yes Total energy expenditure/wk (kcal/kg/wk): 0.097; 0.019 Maintenance achieved: No MPA energy expenditure/wk (kcal/kg/wk): 0.748; 0.018 Maintenance achieved: No
Rogers, 2009 [35, 55] USA (PA)	Group(n): Ix(21); C(20) Sample: Breast cancer survivors (100%) post-	Theory: SCT Duration: 3m Delivery: 21 face-to-face sessions varying in frequency throughout (min	Contact: Provided generic PA information PA measure: Accelerometer to estimate daily PA counts daily & mins MVPA/wk; Aerobic fitness	PA counts mean (SD): Ix: 194,968 (NR); 248,628 (NR); 241,050 (NR) C: 224,944 (NR); 206,799 (NR); 209,375 (NR)	PA counts: 0.004; 0.06 Maintenance achieved: No MVPA mins/wk: 0.63; 0.01 Maintenance achieved: No

PA= physical activity; Ix= intervention; C= control; m= month; wk= week; mins= minutes; ns= not significant; *d*= effect size; NR= not reported; F&V= fruit and vegetables; TTM= Transtheoretical Model; SCT= Social Cognitive Theory; TPB= Theory Planned Behaviour; NEP= nutrition education program; COM= combined print and pedometer group; SR= standard recommendation group; *= successful maintenance achieved

	<p>treatment</p> <p>Mean time since treatment: 34.0m</p> <p>Mean age: 53.0yrs</p> <p>Mean BMI: 30.9 kg/m²</p> <p>Recruitment: Physician referrals; public advertising</p>	<p>weekly contact): 12 supervised individual exercise sessions; 3 individual counseling sessions; 6 group counseling sessions</p> <p>Strategies: 15 (1, 2, 4, 5, 8, 9, 13, 15, 16, 19, 21, 28, 29, 36, 38)</p>	<p>(submaximal treadmill test; ml/kg⁻¹); Back/leg strength (back/leg extensor dynamometer)</p> <p>End-of-Ix: 3m (Ix 95%; C 90% retention)</p> <p>Post-Ix follow-up: 3m (Ix 90%; C 85% retention)</p> <p>Methodological Quality Score: 6 (1, 2, 3, 6, 8, 9)</p>	<p>MVPA mins/wk mean: Ix: 96.2 (NR); 165.8 (NR); 174.9 (NR) C: 113.4 (NR); 116.5 (NR); 92.0 (NR)</p> <p>Aerobic fitness (ml/kg⁻¹) mean: Ix: 24.5 (NR); 29.4 (NR); 28.1 (NR) C: 25.4 (NR); 27.5 (NR); 26.3 (NR)</p> <p>Back/leg strength mean: Ix: 72.9 (NR); 80.9 (NR); 84.8 (NR) C: 68.5 (NR); 64.5 (NR); 69.2 (NR)</p>	<p>Aerobic fitness: 0.06; 0.12</p> <p>Maintenance achieved: No</p> <p>Back/leg strength: 0.02; 0.03</p> <p>Maintenance achieved: Yes</p>
<p>Vallance, 2007; 2008 [30, 56, 57] Canada (PA)</p>	<p>Group(n): Ix COM(93); C SR(96)</p> <p>Sample: Breast cancer survivors (100%) post-treatment</p> <p>Mean time since diagnosis: 39.0m</p> <p>Mean age: 58.0yrs</p> <p>Mean BMI: 27.7 kg/m²</p> <p>Recruitment: Cancer registry</p>	<p>Theory: TPB</p> <p>Duration: 3m</p> <p>Delivery: Received print-based instructional materials at beginning of the intervention</p> <p>Strategies: 12 (1, 2, 3, 4, 5, 7, 8, 13, 16, 21, 29, 38)</p>	<p>Contact: Usual care</p> <p>PA measure: MVPA mins/wk (Leisure Score Index [LSI] of the Godin Leisure-Time Exercise Questionnaire [GLTEQ]); Brisk walking mins/wk</p> <p>End-of-Ix: 3m (Ix 90%; C 89% retention)</p> <p>Post-Ix follow-up: 6m (Ix 72%; C 71% retention)</p> <p>Methodological Quality Score: 6 (1, 2, 5, 8, 9, 10)</p>	<p>MVPA mins/wk mean (SD): Ix: 119 (163); 211 (169); 175 (182) C: 113 (144); 163 (121); 142 (126)</p> <p>Brisk walking mins/wk mean (SD): Ix: 64 (105); 121 (146); 105 (131) C: 101 (143); 102 (105); 94 (124)</p>	<p>MVPA mins/wk: 0.022; 0.21</p> <p>Maintenance achieved: No</p> <p>Brisk walking mins/wk: 0.028; 0.096</p> <p>Maintenance achieved: No</p>

PA= physical activity; Ix= intervention; C= control; m= month; wk= week; mins= minutes; ns= not significant; *d*= effect size; NR= not reported; F&V= fruit and vegetables; TTM= Transtheoretical Model; SCT= Social Cognitive Theory; TPB= Theory Planned Behaviour; NEP= nutrition education program; COM= combined print and pedometer group; SR= standard recommendation group; *= successful maintenance achieved

Appendix 3.B: Electronic supplementary material two forming part of published manuscript ‘Physical activity and/or dietary interventions in breast cancer survivors: A systematic review of the maintenance of outcomes’

Title: Physical activity and/or dietary interventions in breast cancer survivors: A systematic review of the maintenance of outcomes

Journal: Journal of Cancer Survivorship

Authors: Lauren C Spark, Marina M Reeves, Brianna S Fjeldsoe, Elizabeth G Eakin

Affiliation: Cancer Prevention Research Centre, School of Population Health, The University of Queensland, Brisbane, Australia

Author Contact: Lauren Spark, l.spark@uq.edu.au

Online Resource 2: Methodological quality score for trials included in review (n=10)

First author, year	1	2	3	4	5	6	7	8	9	10	Score
Cantarero-Villanueva, 2012 [31]	✓	✓	X	X	X	X	✓	X	?	✓	4
Daley, 2004, 2007 [48, 29]	X	✓	✓	X	X	✓	✓	X	✓	✓	6
Demark-Wahnefried, 2003, 2006 [49, 37]; Clutter Snyder 2007 [50]	✓	✓	✓	X	✓	?	✓	X	✓	X	6
Demark-Wahnefried, 2003, 2007 [51, 36]; Ottenbacher, 2012 [52]; Christy, 2011 [53]	✓	✓	✓	X	✓	?	✓	?	✓	X	6
Hebert, 2001 [28]	X	✓	✓	X	✓	✓	✓	✓	✓	X	7
Mustian, 2009 [32]	✓	✓	✓	X	X	✓	X	X	✓	X	5
Mutrie, 2007 [33]	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	9
Pinto, 2005, 2008 [34, 54]	X	✓	✓	X	X	✓	✓	X	✓	✓	6
Rogers, 2009 [35, 55]	✓	✓	✓	X	X	✓	X	✓	✓	X	6
Vallance, 2007, 2008 [30, 56, 57]	✓	✓	X	X	✓	X	X	✓	✓	✓	6

✓ = present; X = absent; ? = unclear or inadequately described

1) adequate description of randomization and concealment process (i.e., describes sequence generation and allocation concealment); 2) baseline demographic and clinical characteristics reported separately for each group (including baseline values of behavioral outcomes); 3) acceptable attrition ($\leq 20\%$ for \leq six month post-baseline; $\leq 30\%$ for $>$ six month post-baseline 4) assessor blinding; 5) behavior assessed at \geq six month post-intervention follow-up period; 6) intention-to-treat analyses and an appropriate approach to missing data; 7) potential confounders including baseline level of behavior appropriately accounted for in analyses; 8) power calculation reported and trial adequately powered for at least the primary outcome; 9) use of validated behavioral measurements tools; and, 10) summary results presented with estimated effect size (between-group difference) and precision estimates.

Appendix 4.A: SMS for Living Well study description provided to Breast Cancer Network Australia for participant recruitment

SMS for Living Well (SMS-4-LW)

*Exploring use of text messaging to support exercise
and healthy eating in women following treatment for breast cancer*

Research Proposal

The Cancer Prevention Research Centre, based at the University of Queensland in Brisbane, is conducting a study that uses mobile phone text messaging to help promote healthy eating and regular exercise in women following treatment for breast cancer.

Mobile phone text messaging has become a popular and useful method of communication. However, the use of text messaging to help improve healthy living following breast cancer has not been studied before, and your views on how best to do this are needed.

This study is looking for women between the ages of 18 and 75 years who live in the Brisbane area and who own a mobile phone. These women will need to have completed active treatment for breast cancer (this includes surgery, chemotherapy and radiation). The current use of hormone therapy is fine.

The study is looking for all types of women, whether you use your mobile phone often for text messaging or not. As long as you know how to read and send a mobile phone text message, we're interested in your opinions.

This study will run for three weeks and will involve:

- (1) a 30-minute conversation over the telephone with a trained health coach to talk about your exercise and diet, and to set some small diet- and exercise-related goals; and
- (2) receiving text messages for two weeks that will support you in reaching your exercise and eating goals (how often you receive the messages is up to you); and
- (3) visiting The University of Queensland Herston campus, in Brisbane, for a 30-minute interview with your health coach to talk about your experiences of receiving the text messages (this can be done over the telephone if you are unable to attend the Herston campus).

The information from this study will improve the current support offered to women following breast cancer who are trying to lose weight, or maintain a healthy weight.

Participation in this study is entirely voluntary. If you decide to take part and at a later stage change your mind, you are free to withdraw from the study at any time. Withdrawing from the study will not affect your relationship with the Breast Cancer Network Australia or with The University of Queensland.

Appendix 4.B: SMS for Living Well study participant information sheet

SMS for Living Well (SMS-4-LW)

*Exploring use of text messaging to support exercise
and healthy eating in women following treatment for breast cancer*

Participant Information Sheet

Investigators: Lauren Spark – PhD Candidate, Cancer Prevention Research Centre, School of Population Health, The University of Queensland; ph 07 3365 5350
Dr Brianna Fieldsoe – Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland; ph 07 3365 5435
Professor Elizabeth Eakin – Director and Senior Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland; ph 07 3346 4692
Dr Marina Reeves – Senior Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland; ph 07 3365 5598

1. What is the ‘SMS for Living Well (SMS-4-LW)’ study?

We know that, following treatment for breast cancer, it is common for women to experience weight gain. Evidence suggests that regular exercise and healthy eating can lead to weight loss, and can also be good for women’s general health. However, it is unknown how to best support women to do this following treatment.

Mobile phone text messaging has become a popular and useful method of communication. However, the use of mobile phone technology to help people better their lifestyles has only recently become a research area of interest. The use of text messaging to help women following treatment for breast cancer to improve their health has not been studied before. This study would like to understand how women view the use of text messages to support regular exercise and healthy eating. This will be done by sending mobile phone text messages to participants for two weeks and then talking to them about their experiences, opinions, and suggestions.

This pilot study is part of a larger study that looks at the best ways of supporting women following treatment for breast cancer to achieve and maintain weight loss, and make exercise and healthy eating changes to promote longer-term health and wellbeing.

Your participation in this research will help improve the current support offered to women following treatment for breast cancer who are trying to lose weight, or who have lost weight and are trying not to regain weight. This study is being conducted by researchers at The University of Queensland.

2. What will happen if I decide to take part?

This study will last for approximately three weeks and will be conducted in three parts as explained below:

Part 1:

You will be asked to take part in a 30-minute interview over the telephone with a trained health coach to talk about your past and present experiences with weight loss, exercise and healthy eating, and to set some exercise and healthy eating goals that you would like to reach over the next two weeks. For example, an exercise goal may be to increase walking from one day per week to two or three days per week, and a healthy eating goal may be to change your mid-afternoon snack from a piece of cake to a piece of fruit.

Your health coach will help you set realistic goals that are most important to you. You will be given a workbook and an eating and exercise diary to use throughout the study, and to keep at the end of the study. We will also give you a questionnaire to complete. This questionnaire will be used to collect basic demographic information such as your age, time since treatment, and education level. All information will be kept confidential.

Part 2:

You will receive mobile phone text messages from your health coach for two weeks. Each message is designed specifically to suit you and give you the support you need to reach your exercise and healthy eating goals.

There are four types of text messages that you will receive, but the frequency and timing of these messages is up to you. Your health coach will discuss your preferences during your interview in Part 1. These messages aim to:

- (1) check whether you have reached your goals;
- (2) remind you what you have to do to reach your goals;
- (3) provide you with extra support in challenging situations; and
- (4) provide helpful hints to encourage you to reach your goals

You will be asked to reply to some text messages, but this is entirely voluntary and up to you if you want to reply. Reply messages will be at your expense, based on your mobile phone plan rates.

You do not need to have a lot of experience with using mobile phone text messaging, as long as you own a mobile phone and know how to open and read a text message. You can opt out of the study at any time and this will not affect your relationship with the Breast Cancer Network Australia (BCNA), with the BCNA Review and Survey group, or with The University of Queensland.

Part 3:

You will be invited to attend a 30-minute interview with your health coach at The University of Queensland Herston campus (next to the Royal Children's Hospital), in Brisbane. This interview will be scheduled at a time convenient for you. If it is not convenient for you to attend this interview face-to-face, we can conduct the interview over the telephone. During this interview we will be interested in getting your opinions on what you thought about receiving the text messages. We will ask questions about what you did and did not like, your experiences over the last two weeks, and we will also be interested in any suggestions for how to improve the way we might use text messages to support women in exercising and healthy eating. This interview will be voice recorded.

3. What are the benefits to me if I take part in this study?

We cannot guarantee that you will receive any personal benefit from participating in the study. We know that regular exercise and healthy eating may lead to improved health. However, we do not know if using text messages will be successful in helping you to increase your exercise or healthy eating, or if any changes will be long lasting. If you do take part, you will receive a summary report of the results and implications of this study. This study will provide us with valuable information to develop and improve health and wellbeing support currently offered to women following treatment for breast cancer. Therefore, your participation may help improve the health of other women in the future.

4. What are the risks in taking part in this study?

You may experience physical discomfort or muscle soreness as a result of increased exercise. However, the risks of involvement are not expected to be any greater than those faced by women doing physical activity in day-to-day living. Your health coach will work with you to make sure that you set realistic exercise goals that aren't likely to cause you injury or discomfort.

You will be asked some questions of personal nature about your breast cancer experience and any weight changes after your breast cancer treatment. These topics may be sensitive in nature to some women, and may evoke some level of emotional discomfort. You are free to choose not to answer any questions that you do not feel comfortable answering, and you are free to withdraw from the study at any time.

5. Participation is voluntary

Taking part in this study is voluntary, if you do not wish to take part you do not have to. If you decide to take part and at a later stage change your mind, you are free to withdraw from the study at any time. Withdrawing from the study will not affect your relationship with the Breast Cancer Network Australia (BCNA) or with The University of Queensland. If you do decide to withdraw, we would be grateful if you could notify a member of the research team.

6. Privacy & confidentiality

All information will be treated with the strictest confidence by the research team. You will be allocated an identification (ID) number so that your information can be stored in computer files without your name. Identifiable information (e.g., consent forms and audio records) will be stored in a locked filing cabinet accessible only by the investigators named above. All other data (paper and electronic) will only be identifiable by your study ID number, and electronic files will be password-protected. You will not be identified in any reports or presentations that arise from the research. Your mobile phone telephone number will be kept confidential and not used for purposes other than participation in this study.

7. Results of project

At the completion of the study, each participant will receive a letter thanking them for participating in the study and a summary of the research findings will be included with this letter.

8. Who can I speak to if I have questions?

This study has been cleared by the School of Population Health Research Ethics Committee of The University of Queensland in accordance with the National Health and Medical Research Council's guidelines. You are welcome to discuss your participation in this study with project staff, contactable on:

Lauren Spark, on 07 3365 5350, email: l.spark@uq.edu.au

Dr. Brianna Fjeldsoe, on 07 3365 5435, email: b.fjeldsoe@sph.uq.edu.au

However, if you would like to speak to an officer of the University not involved in the study, you may contact the Chair of the Ethics Committee on 07 3365 5541.

Appendix 4.C: SMS for Living Well study text message example sheet

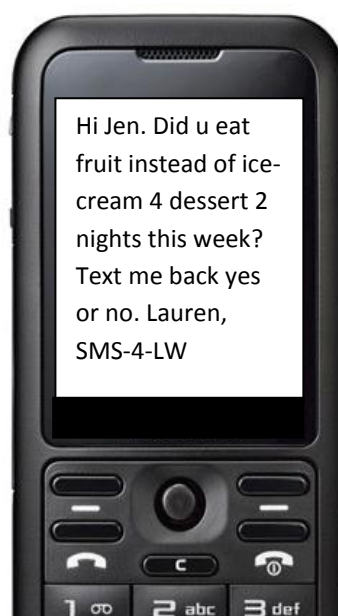
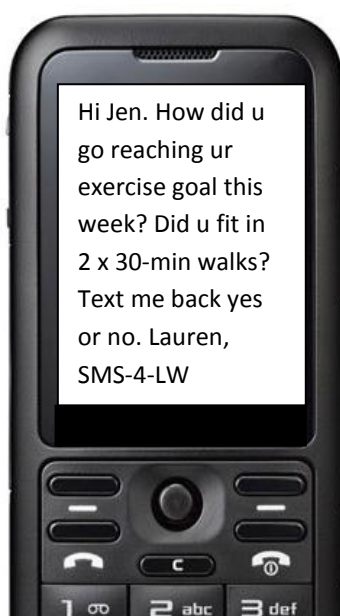
SMS for Living Well (SMS-4-LW)

*Exploring use of text messaging to support exercise
and healthy eating in women following treatment for breast cancer*

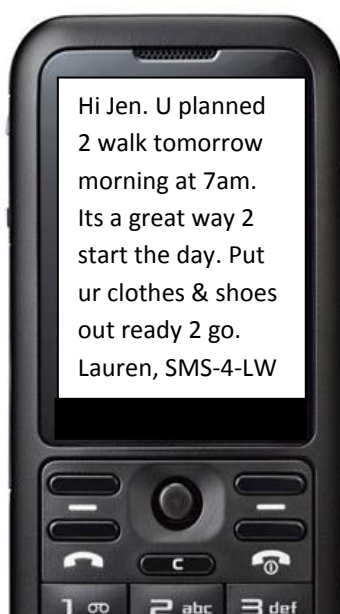
Text Message Information Sheet

Here are some examples of the types of text messages you may receive.

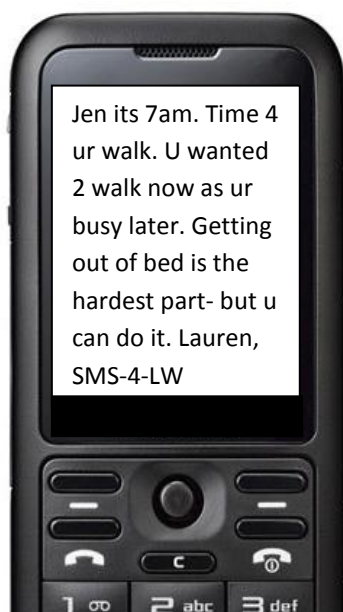
To check how you are going with reaching your goals...



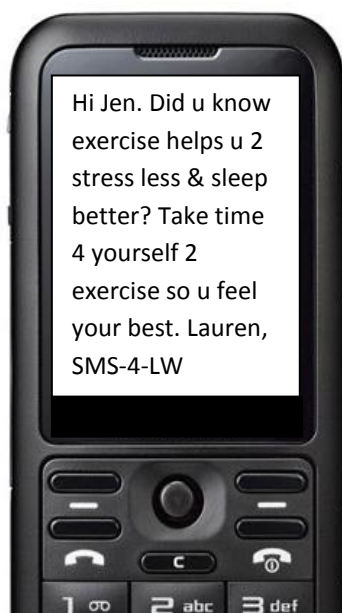
To remind you of what you have planned to do to reach your goals...



To provide you with extra support in challenging situations...



To provide helpful hints to encourage you to reach your goals...



Appendix 4.D: SMS for Living Well study participant consent form

SMS for Living Well (SMS-4-LW)

*Exploring use of text messaging to support exercise
and healthy eating in women following treatment for breast cancer*

Participant Consent Form

Investigators: Lauren Spark – PhD Candidate, Cancer Prevention Research Centre, School of Population Health, The University of Queensland; ph 07 3365 5350
Dr Brianna Fjeldsoe – Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland; ph 07 3365 5435
Professor Elizabeth Eakin – Director and Senior Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland; ph 07 3346 4692
Dr Marina Reeves – Senior Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland; ph 07 3365 5598

YES, I freely agree to participate in this project according to the conditions in the Participant Information Sheet.

I have read the Participant Information Sheet and I understand the extent of my involvement in this study.

I have had the opportunity to ask questions and I understand that I may request further information about the study as it proceeds.

I understand that there are no foreseeable risks associated with my involvement in this study.

I understand that my participation is voluntary and I am free to withdraw from this study at any time without penalty.

I understand that by agreeing to participate in this study I will receive mobile phone text messages sent to my personal mobile for a period of two weeks, at a time and frequency determined by myself.

I understand that all data will be treated confidentially and the researcher has agreed to not reveal my identity and personal details in any reports or publications resulting from this study.

Participant's Full Name (please print):

Participant's Signature: Date:

Contact phone: Mobile:

Appendix 4.E: SMS for Living Well study goal setting telephone interview script

Hi _____. This is Lauren calling from The University of Queensland, SMS for Living Well study. Is now still a convenient time to conduct our 30-minute telephone interview?

NO → When would be the best time to call back?

YES → Great! So, the aim of this telephone interview is for me to get a better understanding of your experiences and challenges with weight loss, healthy eating and exercise in the past. Then, based on your current exercise and eating habits, together we will come up with at least one healthy eating and one exercise goal for you to work towards over the next two weeks. I will be taking detailed notes throughout the call. To get started, let's just start by talking about your experiences with weight loss....

WEIGHT LOSS:

Have you ever tried to lose weight in the past?

- *What did you do? What worked? What didn't?*

DIET:

How do you feel about your current diet? *(e.g., do you think you are eating a healthy diet, are you eating too much or too little of something, skipping breakfast)*

Prompts:

- What changes would you like to make to your current diet? *(e.g., eat more vegetables, eat less takeaway or junk food, take lunch from home)*

OUTCOME EXPECTANCY:

If you were to make these changes to your diet, what two things do you expect will happen? *(e.g., have more energy, feel hungry)*

1).

2).

EXERCISE:

Are you currently doing any exercise? *(if yes - what types of activities, for how long, and how often are you doing them? e.g., walking for 15 mins 2 days a week)*

Prompts:

- What changes would you like to make to your current exercise? *(e.g., do more, try a new activity, increase duration or intensity)*

OUTCOME EXPECTANCY:

If you were to make these changes to your exercise, what two things do you expect will happen
(e.g., have more energy, have sore muscles)

1).

2).

GOAL-SETTING

Now we are going to set at least one SMART eating and one SMART exercise goal that you can work towards over the next two weeks. The best way to set a goal is to make it SMART - this means specific, measurable, achievable, realistic, and timely. Setting a goal this way makes it really concrete and easier for you to track your progress towards achieving it. So, instead of just saying that you want to exercise more, you set a goal for exactly what you're going to do and when (for example, I'm going to walk Monday, Wednesday, Friday from 6am to 6.30am at a brisk pace for the next 2 weeks.) Setting a really specific goal like this actually makes it easier to achieve, because you know exactly when you've reached it.

SMART goals (page 7-10); Rewards (page 8)

For a healthy eating goal:

Starting on _____ (day of week),

I am going to _____ at breakfast/lunch/dinner/snacks.

I am going to do this _____ (number) days this week.

To do this I am going to _____ (if need to go grocery shopping, plan meals).

If I do this for TWO weeks, I will _____ (reward).

I'd like you to please write down this goal in your diary, so that we both have a record of it.

On a scale from one to ten, with one being 'not at all confident' and ten being 'very confident' how confident are you in making this change to you? _____

If less than 7, think of easier goals to achieve in two weeks.

For an exercise goal:

Starting on _____ (day of week),

I am going to _____ (type of activity) for _____ (minutes).

I am going to do this _____ (number) days this week.

To do this I am going to _____ (if need to
buy walking shoes, ask friend to go walking).

If I do this for TWO weeks, I will _____ (reward).

I'd like you to please write down this goal in your diary, so that we both have a record of it.

On a scale from one to ten, how confident are you in making this change to you? _____

If less than 7, think of easier goals to achieve in two weeks.

As you know, we are testing whether we can support women to reach their goals via text messaging. So now I'm going to suggest a few ways we can do this.

PLANNING – DIET: *Section two of the workbook is all about the things you can do to plan for success*

Thinking first about your diet goal over the next two weeks, what specific times or days are you going to do this (e.g., going to eat breakfast at 7am every day, going to swap ice-cream for fruit after dinner).

I would like to text you at these times to remind you about your plan to do this.

What would be the best time to send you a message about this (e.g., half hour before, during)?

How many texts would you like to get about this? (i.e., if about lunch everyday, want text everyday or only just once or twice?)

PLANNING – EXERCISE:

Thinking about your exercise goal over the next two weeks, what specific times or days are you going to do this (e.g., going to go for a walk every morning before breakfast, going to get off the bus one stop early every weekday and walk to work)

I would like to text you at these times to remind you about your plan to do this.

What would be the best time to send you a message about this (e.g., half hour before, during)?

How many texts would you like to get about this? (i.e., if walking everyday, do want texts everyday or only once or twice?)

SELF-MONITORING: *Tips on keeping track of your progress are discussed on page 12 and 13*

You can see in the diary there are spaces to write down your goals and keep a track of how you are going.

Can you tell me how you think you will use the diary *(e.g., keep it in your handbag, fill it in every night, keep it on the fridge)*

PROBLEM SOLVING – DIET:

It is normal to experience some setbacks on your journey to increasing your exercise or eating a more healthy diet. However, the important thing is to see setbacks as temporary and not let them stop you from getting back on track; this is where problem solving can come in very handy.

Problem solving is discussed on pages 21 to 23 in your workbook.

In the next two weeks, what could get in the way of reaching your eating goal *(e.g., have party to go to on the weekend, have morning tea every day at work with a friend, being too tired to cook).*

So, if this does happen, what do you think a solution to this problem may be? *(see table with barriers & solutions)*

It may be helpful for me to send you a message at these times to remind you about how you have planned to overcome this problem.

IF SPECIFIC EVENT → Get information of event, time, day etc (i.e., party)

IF NOT SPECIFIC EVENT → Get information on how often would like this reminder, time etc. (e.g., Mondays, Wednesdays and Fridays at 7pm remind to make healthy lunch for tomorrow)

PROBLEM SOLVING – EXERCISE:

In the next two weeks, what could get in the way of you exercising as we have planned (e.g., too tired when get home from work, in too much of a rush in the morning).

So, if this does happen, what do you think a solution to this problem may be?

It may be helpful for me to send you a message at these times to remind you about how you have planned to overcome this problem.

IF SPECIFIC EVENT → Get information of event, time, day etc (i.e., party)

IF NOT SPECIFIC EVENT → Get information on how often would like this reminder, time etc. (e.g., Mondays, Wednesdays and Fridays at 7pm remind to make healthy lunch for tomorrow)

SOCIAL SUPPORT: *Tips on page 15-17 about how others can be more supportive of your goals*

DIET - Can you think of *something* someone can do for you to help you reach *diet* goal over the next two weeks? (e.g., not bring takeaway home for dinner)

Who would the best person be to provide this support for you (e.g., a *friend* to go for a walk with)

NAME =

EXERCISE - Can you think of *something* someone can do for you to help you reach your *exercise* goal over the next two weeks? (e.g., not bring takeaway home for dinner)

Who would the best person be to provide this support for you (e.g., a *friend* to go for a walk with)

NAME =

Over the next two weeks, in addition to the other types of messages we've just been talking about, I will also send you text messages once per week asking you if you have reached your eating and exercise goals for that week. I would like you to reply back to these messages letting me know how you are going. Referring to your diary will help you with this. Replying to this message is totally voluntary and would be at your expense based on the cost of sending a text message as per your mobile phone provider. However, from this check-in with you, I will be able to see where I can offer you additional support.

What time of day would you prefer to receive these messages (includes social support, outcome expectancy, self-monitoring tracking tips)

Great! That sums up the questions for this interview, I would just like to mention a few additional things:

- 1) When you receive a text message from me, it will come from a random mobile number that will change often. But I will always sign off as Lauren SMS-4-LW and to write back to me, all you have to do is use the 'reply' function.
- 2) You don't have to reply to any messages other than the ones asking whether you reached your goals for that week or not. However, please feel free to message me at any stage during the two weeks, although sometimes I may not be able to reply.
- 3) You can decide at any time to pull out of the study. If you could let me know by sending me a text, emailing me, or calling me that would be great. But please keep in mind that we are trying to get as much feedback as possible, negative and positive, from this study so your participation in the final feedback interview would be fantastic, even if you hated getting the text messages. It would also be very helpful for us if you could jot down any ideas, suggestions, thoughts or comments you have throughout the study on some of the spare pages in the tracking diary, and bring the diary to the final interview.
- 4) In regards to the final interview, this will involve you coming into our research centre here at the University of Queensland, Herston campus, for a 30 minute interview with me to discuss your experiences throughout the study. Would you like to schedule this appointment now or would you prefer I call you back at the end of the two weeks?

If make appointment THEN → I will mail/email you a reminder letter of this appointment with a map of where to come.

- 5) I will start sending you text messages in the next few days. Thank you again for participating in this study and I will: **(a)** call you to arrange an interview time in two weeks' time **OR** **(b)** I will post your interview information out today and look forward to meeting you on _____ (date of interview).

Appendix 4.F: SMS for Living Well study feedback interview script

- Reiterate that the session will be recorded but that any information shared in the session will be de-identified when reported and is confidential.
- Start recording (state participant ID & date)
- Thank you for being involved in this study
- This study will inform part of the larger Living Well after Breast Cancer study, which is a six-month telephone counselling weight loss program for women after treatment for breast cancer.
- We know that following a weight loss study, it is common for people to re-gain weight. But we also know that extending contact with participants can help them maintain their weight after the end of the intervention. My PhD is investigating whether extended contact via text messaging to maintain lifestyle changes is feasible and acceptable to women following a weight loss program. So we are designing a program to add onto the end of the LWaBC study that enables us to keep in contact with women after the 6-month program in an attempt to maintain the positive changes they have made to their exercise and eating habits.
- However, we don't know whether using text messaging to support exercise and healthy eating is acceptable. So the aim of this pilot is to test this and to get as much feedback as possible about this.
- Over the past two weeks I have been sending you text messages, and I want you to focus on these while I ask you some questions. You may want to get our mobile phone out at some points during the interview to check specific texts that I sent you, but I also have a record of them here with me.
- Please don't be afraid to share any negative experiences you had with receiving the text messages as this hasn't been done before and we are in the very early stages of designing a text message intervention. All comments, be it positive or negative, are extremely helpful in determining how best to move forward. No feedback you give me here today will jeopardise your relationship with the BCNA or with The University of Queensland.
- You are free to withdraw at any stage from this interview, and you are also free to not answer any questions in which you do not feel comfortable answering.

- Before we started this study two weeks ago, would you say that you were a frequent text message user?

Likes & dislikes

- To begin with, overall how did you find the experience of being in this study?
- What did you like most about receiving the text messages? (e.g., tailored, timing and frequency self-determined) *Why?*
- What did you like the least about receiving the text messages? (e.g., the frequency, too repetitive) *Why?*
- At any stage did you get annoyed or frustrated when you received a message. *When? Why?*
- You were getting one to two texts per day, was this too many?

Usefulness & acceptability

- When you received a text from me, what did you do with it? (e.g., read it, delete it, store it)
- Did you re-read any texts at any time? *If yes, which ones?*
- Were the texts sent to you at the times you requested? *If no, how did this affect you?*
- Was the language used in the text messages easy to understand?
 - You (u)
 - Be (b)
 - Too, to (2)
 - Your (ur)
 - See (c)
- Do you think the text messages helped you to stay on track to reach your goals? *If yes, How? No, why?*
- Did you feel the content of the messages were sufficiently tailored to you? *How?*
- If I was to offer you the chance to continue receiving text messages from me over the next few months to help you achieve short-term goals for your diet and exercise, how would you feel about this?
- In the LWaBC study, women will complete their 6-month telephone counselling program and then I anticipate offering them the opportunity to receive text messages from me to help them maintain the changes they have made. If you were

in this situation, how do you think you would feel about receiving these types of messages I have sent you over the last two weeks, but on less frequent but regular basis, say once every two weeks for six months? *Do you think you would be interested? Do you think you would like it? Do you think you would tire of getting the messages early on?*

Types of texts

- I sent you a range of different messages across the two weeks. Can you recall which specific text messages you found most helpful or supportive? *Why?* (e.g., goal check, ones that encouraged me to focus on my goal)
- Did you find any specific text messages annoying or unhelpful? *Why?* (e.g., goal check because made frustrated as didn't achieve goal)
- Do you think it would be useful for you receive a one-off text message when you knew you were going to be in a situation where you were challenged to reach your goals, say at a party where there would be lots of high calorie food available?
- Was it useful when I texted you once per week to check whether you reached your goals?
- Did you like that I replied to your response on the goal check to either congratulate you or offer support for achieving your goal next week?
- Is there any particular reason why you didn't reply to the goal check message I sent to you on Sunday?
- Do you think receiving this message back from me was important, or do you think it wouldn't have made a difference to you whether I replied?
- Was it useful when I texted you to remind you of when you had **planned (cue)** to exercise or eat well? *For example, the messages I sent to you at about 5pm to remind you to eat a healthy dinner, and in the morning to remind you to go for your walk? Were these helpful to be received at the specific times you had planned to do the behaviour?*
- Was it helpful when I texted you to remind you about a **barrier** that may stop you from reaching your goal, and also gave a solution to this problem? *For example, I reminded you to prevent from being tired & missing your morning walk, to be in bed by 10pm the night before. Was this helpful?*
- How did you feel about receiving the messages early in the morning to help with your exercise? Was this helpful or annoying?

- Did you find it confusing when I asked about both your eating and exercise goals at the same time?
- Was it useful for me to refer you back to using the diary to help you keep track of your goals and your progress?
- Is there anything that you would have liked to been able to change once you started receiving the messages, such as the timing or the frequency in which you received the messages?
- Can you think of any other information that we should gather about women at the initial interview that you think may be important to tailor to in the texts?

General feedback

- Would your impression of the text messages change if you knew that a computer program rather than a person was writing and responding to your texts? (i.e., is it important to know that another person is providing you with social support more so than what the actual message says)
- Do you have any suggestions about how to maximise the impact of the text messages relating to women's health?
- Do you have any general feedback about what you liked or disliked, or any comments about your experiences with receiving the text messages over the last two weeks?

Thank you very much for participating in this study and taking the time to share your experiences with me. Your feedback will be invaluable to us moving forward with designing a program to offer to women when they have finished the LWaBC study. I will send you a summary of the results in the coming months.

Appendix 5.B: Living Well after Breast Cancer extended contact intervention initial tailoring telephone call script

- Discuss feedback (what doing well at, what could improve)
- Reminder of Program Goals to work towards/maintain:
 - PA = 7 x 30min MVPA sessions per week
 - Diet = 2 fruit & 5 veg
 - Fibre intake
 - Saturated fat intake
 - Total fat intake
 - 120 mins or less per day of leisure time sitting
- The goal of this next phase of LWaBC is to help you reach these Programs Goals and then to help you keep it up for the next 6 months.
- The next step is re-assessing your goals for the next six weeks. Over the next 6 months I will be checking in with you via telephone or text message to see if you would like to change your goals. But, at this stage, we are just going to set some goals based on what you are doing now and what you would like to be doing over the next 6 weeks.

<p>What would you like the focus of the text messages to be over the next 6 weeks?</p>

- ☐ **Weight + PA**
- ☐ **Weight + Diet**
- ☐ **Weight + PA + Diet**

What weekly goals would you like to set for the next 6 weeks?

☐

PA:

I am going to _____ (type of activity) for _____ (minutes).

I am going to do this _____ (number) days per week.

If I achieve this, I will _____ (reward).

To keep things interesting, an alternative I could try includes _____
(type of activity).

☐

DIET:

I am going to _____ at
breakfast / morning tea / lunch / afternoon tea / dinner / dessert / supper / snacks

If I achieve this, I will _____ (reward).

To keep things interesting, an alternative I could try includes _____
(type of food substitute/recipe/ways of cooking)

☐

WEIGHT:

My starting weight is _____ (kgs). I will lose/maintain _____ (kgs) **BY 6 WEEKS.**

If I achieve this, I will _____ (reward).

To help you achieve these goals I'm going to stay in touch via text messages.

- I will send you minimum **one message each fortnight** to check in with you
- Everything about the text messages is very flexible, and it is totally up to you about how you receive them. You can also let me know at any time if you would like to change anything about the messages I am sending you.
- I will be calling you in 12 weeks time to talk about how you have gone over the last 12 weeks, and this will be another opportunity to let me know if you would like to change anything about the text messages.

I want to understand how you're going to achieve your goals so that I can offer you the best support.

WEIGHT

As you know, it's important that you keep monitoring your weight. I want to send a message each fortnight to remind you to do this.

What DAY and TIME would you like to receive a fortnightly message reminding you to WEIGH yourself?

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

PHYSICAL ACTIVITY

What specific TIMES and DAYS do you plan to do your PHYSICAL ACTIVITY?

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

What specific things could you do to make sure you are prepared to do your PHYSICAL ACTIVITY as you have planned? (Minimum of 2)

1. _____
2. _____

How MANY messages would you like to receive reminding you about your plans to do PHYSICAL ACTIVITY PER WEEK OR FORTNIGHT? (please circle) **MAXIMUM 2/week**

0 1 2 3 4 5 6 7

When would be the best time for you to receive a message about this? (e.g., 12pm lunchtime, the night before, 6pm an hour before dinner)

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

TOTAL PHYSICAL ACTIVITY MESSAGES = PER WEEK

If you meet your PHYSICAL ACTIVITY GOALS, what are some of the physical or mental things you EXPECT will happen? (*Minimum of 3*)

1. _____

2. _____

3. _____

WHO is the most likely person that will support your PHYSICAL ACTIVITY goals, and WHAT can they do to support you?

FIRST NAME = _____

RELATIONSHIP = _____

ACTION = _____

What are some of the BARRIERS that may get in the way of your PHYSICAL ACTIVITY GOALS and can you think of SOLUTIONS to these barriers? (*Minimum of 2 each*)

Barrier 1: _____

Solution 1: _____

Barrier 2: _____

Solution 2: _____

HOW OFTEN would you like me to check-in and message you about whether you have met your **PHYSICAL ACTIVITY** goals? *(You as the counsellor will be able to reply to this message to give participants feedback on how they are going)* **PLEASE FEEL FREE TO JUST RESPOND 'YES' OR 'NO' TO THIS MESSAGE 😊**

Timing:

☐

Weekly

☐

Fortnightly

What day and time would work best for me to check on your goal? *[May want to suggest Monday as easy to reflect on past week]*

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

HEALTHY EATING

What specific TIMES and DAYS do you plan to follow through with your HEALTHY EATING goals?

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

What specific things could you do to make sure you are prepared to meet your HEALTHY EATING goals as you have planned? (*Minimum of 2*)

1. _____

2. _____

How MANY messages would you like to receive reminding you about your HEALTHY EATING plans PER WEEK OR FORTNIGHT? (*please circle*) MAXIMUM 2/week

0 1 2 3 4 5 6 7

When would be the best time for you to receive a message about this? (*e.g., 12pm lunchtime, the night before, 6pm an hour before dinner*)

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

TOTAL HEALTHY EATING MESSAGES = PER WEEK

If you meet your HEALTHY EATING goals, what are some of the physical or mental things you EXPECT will happen? *(Minimum of 3)*

1. _____
2. _____
3. _____

WHO is the most likely person that will support your HEALTHY EATING goals, and WHAT can they do to support you?

FIRST NAME = _____ RELATIONSHIP = _____

ACTION = _____

What are some of the BARRIERS that may get in the way of your HEALTHY EATING goals, and can you think of SOLUTIONS to these barriers? *(Minimum of 2 each)*

Barrier 1: _____

Solution 1: _____

Barrier 2: _____

Solution 2: _____

HOW OFTEN would you like me to check-in and message you about whether you have met your **HEALTHY EATING** goals? (You as the counsellor will be able to reply to this message to give participants feedback on how they are going) **PLEASE FEEL FREE TO JUST RESPOND 'YES' OR 'NO' TO THIS MESSAGE 😊**

Timing:

☐

Weekly

☐

Fortnightly

What day and time would work best for me to check on your goal?

IF WOULD LIKE GOAL CHECK MESSAGES FOR PA & DIET ON THE SAME DAY, ENCOURAGE DIFFERENT DAYS (“I don’t want to overwhelm you with too many messages on one day, so how about I send you the PA goal check messages on Friday and the Diet goal check messages on Monday?”)

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

<p>REFLECT ON TOTAL NUMBER OF TEXTS PER FORTNIGHT FROM TALLY SHEET</p>

<p>Check this frequency is suitable & revise if necessary</p>
--

At weeks 6, 18 & 24 I want to check in with you via text message about your current weight. At these points, you will receive a few messages, often on the same day, about your weight, diet, and exercise. These messages will be reminding you to re-set your goals and you can let me know if you would like to change your goals. But, most importantly, they will let me know how you are going reaching your weight goals.

That sums up the questions about your text messages, I would just like to mention a few additional things:

- 1) You will receive a message from me asking you to confirm that I have your correct mobile number, please reply 'yes' to this so I can confirm I have your correct details.
- 2) Then you will start receiving messages from me in the next week or so.
- 3) When you receive a message from me, please save this number in your phone and you can use this number to message me at any stage (this will be a different number to the number I may have used when sending you messages in the past).
- 4) You don't have to reply to any messages other than the ones asking whether you reached your goals or not, and the ones checking in asking you if you would like to set a new goal. If you reply to any messages they will be charged as per your mobile phone plan.
- 5) When you are replying to the goal check messages, please feel free just to write 'yes' or 'no' back in reply to my questions.
- 6) You can text me at any time to change anything about the messages I am sending you. I can adjust the timing, content, and number of messages to whatever suits you. Please just text and let me know.
- 7) You can decide at any time to pull out of the study. If you could let me know by sending me a text, that would be great. But please keep in mind that this type of study hasn't been done before so your participation in the final feedback interview with Lauren would be fantastic. If you are finding you are getting too many messages, we can always drop it down to the minimum of one text per fortnight.
- 8) I will call you in about 12 weeks time to have a brief check-in telephone call to see how you are going. Good luck with everything and I will talk to you then.

Appendix 5.C: Living Well after Breast Cancer extended contact intervention week 12 tailoring telephone call script

I just wanted to check in with you to see how you have been going over the last few months with your diet, exercise & weight loss.

Re-cap on last 12 weeks:

- You previously set goals to:
PA:
DIET:
WEIGHT:
- How have you gone trying to reach your goals? (*e.g., successful, if unsuccessful then why?*)

- You have been receiving text messages focused on weight AND:

PA ☐ DIET ☐

- Have you had issues with the way you have been getting the text messages? (*e.g., too many, too few, unsuitable timing, too focused on one aspect etc???*)

- I would like to continue sending you text messages over the next three months to help you maintain your healthy lifestyle, and today I would like to work with you to set some goals that you may like to achieve over the next 6 weeks. Even if you would like to keep the same goals, I would like to ask similar questions to last time so I can collect all the information I need for your text messages.

Reminder of Program Goals to work towards/maintain:

- PA = 7 x 30min MVPA sessions per week
- Diet = 2 fruit & 5 veg
- Fibre intake; Saturated fat intake; Total fat intake
- 120 mins or less per day of leisure time sitting

What would you like the focus of the text messages to be over the next 6 weeks?

- ☐ **Weight + PA**
- ☐ **Weight + Diet**
- ☐ **Weight + PA + Diet**

What weekly goals would you like to set for the next 6 weeks?

Your previous PA goal was to:

Reward:

Alternative activity:

☐ **PA:**

I am going to _____ (type of activity) for _____ (minutes).

I am going to do this _____ (number) days per week.

If I achieve this, I will _____ (reward).

To keep things interesting, an alternative I could try includes _____
(type of activity).

Your previous DIET goal was to:

Reward:

Diet alternative:

☐ **DIET:**

I am going to _____ at

breakfast / morning tea / lunch / afternoon tea / dinner / dessert / supper / snacks

If I achieve this, I will _____ (reward).

To keep things interesting, an alternative I could try includes _____
(type of food substitute/recipe/ways of cooking)

WEIGHT

Your previous WEIGHT goal was to:

Your starting weight was:

Reward:

☐

WEIGHT:

My current weight is _____ (kgs). I will lose/maintain _____ (kgs) **BY 6 WEEKS**.

If I achieve this, I will _____ (reward).

As you know, it's important that you keep monitoring your weight and I would like to keep sending you a fortnightly message reminding you to do this.

Are you happy to continue receiving this message on: _____ @ _____ ???

☐

YES

☐

NO → *(Please fill in below – everyone must receive this message)*

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

PHYSICAL ACTIVITY

What specific TIMES and DAYS do you plan to do your PHYSICAL ACTIVITY?

☐

Was previously receiving messages on: _____ @ _____

Same

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

What specific things could you do to make sure you are prepared to do your PHYSICAL ACTIVITY as you have planned? (Minimum of 2)

Previous preparatory activities included: _____

☐

Same

1. _____

2. _____

How MANY messages would you like to receive reminding you about your plans to do PHYSICAL ACTIVITY PER WEEK OR FORTNIGHT? (circle) MAXIMUM 2 per week

Was previously receiving: ____ messages/week/fortnight on _____ @ _____

☐

Same

0 1 2 3 4 5 6 7

When would be the best time for you to receive a message about this? (e.g., 12pm lunchtime, the night before, 6pm an hour before dinner)

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

TOTAL PHYSICAL ACTIVITY MESSAGES = PER WEEK

If you meet your PHYSICAL ACTIVITY GOALS, what are some of the physical or mental things you EXPECT will happen? (Minimum of 3)

Previous expectations included:

_____	Was this experienced? YES / NO
_____	Was this experienced? YES / NO
_____	Was this experienced? YES / NO

☐

Keep same expectancies

1. _____
2. _____
3. _____

WHO is the most likely person that will support your PHYSICAL ACTIVITY goals, and WHAT can they do to support you?

Previous support person was:

_____ who could _____ Was this person supportive? **YES / NO**

☐

Keep same support person AND action

FIRST NAME = _____

RELATIONSHIP = _____

ACTION = _____

What are some of the BARRIERS that may get in the way of your PHYSICAL ACTIVITY GOALS and can you think of SOLUTIONS to these barriers? (Minimum of 2 each)

Previous barriers and solutions included:

1. BARRIER = _____ SOLUTION = _____

Did this work? **YES / NO**

2. BARRIER = _____ SOLUTION = _____

Did this work? **YES / NO**

☐

Keep same barriers & solutions

Barrier 1: _____

Solution 1: _____

Barrier 2: _____

Solution 2: _____

HOW OFTEN would you like me to check-in and message you about whether you have met your PHYSICAL ACTIVITY goals?

Was previously receiving: _____ messages/week/fortnight on _____ @ _____ ☐ **Same**

Timing:

☐

Weekly

☐

Fortnightly

What day and time would work best for me to check on your goal?

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

HEALTHY EATING

What specific **TIMES** and **DAYS** do you plan to follow through with your **HEALTHY EATING** goals? ☐

Was previously receiving messages on: _____ @ _____ **Same**

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

What specific things could you do to make sure you are prepared to meet your **HEALTHY EATING** goals as you have planned? (*Minimum of 2*)

Previous preparatory behaviours included: _____

Did this help? **YES / NO**

☐

Keep same preparatory behaviors

1. _____

2. _____

How **MANY** messages would you like to receive reminding you about your **HEALTHY EATING** plans **PER WEEK OR FORTNIGHT?** (*please circle*) **MAXIMUM 2/week**

Was previously receiving: ____ messages/week/fortnight on _____ @ _____ ☐ **Same**

0 1 2 3 4 5 6 7

When would be the best time for you to receive a message about this? (*e.g., 12pm lunchtime, the night before, 6pm an hour before dinner*)

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

TOTAL HEALTHY EATING MESSAGES = PER WEEK

If you meet your HEALTHY EATING goals, what are some of the physical or mental things you EXPECT will happen? (Minimum of 3)

Previous expectations included:

_____	Was this experienced? YES / NO
_____	Was this experienced? YES / NO
_____	Was this experienced? YES / NO

☐

Keep same expectancies

1. _____
2. _____
3. _____

WHO is the most likely person that will support your HEALTHY EATING goals, and WHAT can they do to support you?

Previous support person was:

_____ who could _____ Was this person supportive? **YES / NO**

☐

Keep same support person AND action

FIRST NAME = _____

RELATIONSHIP = _____

ACTION = _____

What are some of the BARRIERS that may get in the way of your HEALTHY EATING goals, and can you think of SOLUTIONS to these barriers? (Minimum of 2 each)

Previous barriers and solutions included:

1. BARRIER = _____ SOLUTION = _____

Did this work? **YES / NO**

2. BARRIER = _____ SOLUTION = _____

Did this work? **YES / NO**

☐

Keep same barriers & solutions

Barrier 1: _____

Solution 1: _____

Barrier 2: _____

Solution 2: _____

HOW OFTEN would you like me to check-in and message you about whether you have met your HEALTHY EATING goals?

Was previously receiving: _____ messages/week/fortnight on _____ @ _____ ☐ **Same**

Timing:

☐

Weekly

☐

Fortnightly

What day and time would work best for me to check on your goal?

	Mon	Tues	Wed	Thus	Fri	Sat	Sun
Time							

FINAL INSTRUCTIONS

REFLECT ON TOTAL NUMBER OF TEXTS PER FORTNIGHT FROM TALLY SHEET

Check this frequency is suitable & revise if necessary

Today we have focused on what you will do for the next 6 weeks. So in 6 and 12 weeks times I want to check in with you via text message about your current weight. At these points, you will receive a few messages, often on the same day, about your weight, diet, and exercise. These messages will be reminding you to re-set your goals and you can let me know if you would like to change your goals. But, most importantly, they will let me know how you are going reaching your weight goal.

I would just like to remind you of a few additional things:

- 1) I will make the changes to how you are receiving messages as soon as possible, this may mean you don't receive your normal texts for a few days.
- 2) You don't have to reply to any messages other than the ones asking whether you reached your goals or not, and the ones checking in asking you if you would like to set a new goal. If you reply to any messages they will be charged as per your mobile phone plan.
- 3) When you are replying to the goal check messages, please feel free just to write 'yes' or 'no' back in reply to my questions.
- 4) You can text me at any time to change anything about the messages I am sending you.
- 5) You can decide at any time to pull out of the study. If you could let me know by sending me a text, that would be great. But please keep in mind that this type of study hasn't been done before so your participation in the final feedback interview with Lauren would be fantastic. If you are finding you are getting too many messages, we can always drop it down to the minimum of one text per fortnight.
- 6) Lauren or Jane will contact you in 12 weeks time to schedule your 12 month health assessment.
- 7) It has been a pleasure talking to you!! All the best for the future!!!

**Appendix 5.D: Living Well after Breast Cancer extended contact intervention
initial tailoring telephone call participant profile sheet**

PARTICIPANT PROFILE SHEET

FORTNIGHTLY REMINDER TO WEIGH SELF → ALL GET FORTNIGHTLY

TOTAL = 1 / FORTNIGHT

PHYSICAL ACTIVITY TEXTS: → CONVERT WEEKLY TO FORTNIGHTLY

TOTAL = / FORTNIGHT

HEALTHY EATING TEXTS: → CONVERT WEEKLY TO FORTNIGHTLY

TOTAL = / FORTNIGHT

PHYSICAL ACTIVITY GOAL CHECK TEXT:

☐ WEEKLY
OR
☐ FORTNIGHTLY
OR
☐ NONE

TOTAL = / FORTNIGHT

DIET GOAL CHECK TEXT:

☐ WEEKLY
OR
☐ FORTNIGHTLY
OR
☐ NONE

TOTAL = / FORTNIGHT

TOTAL MESSAGES = PER FORTNIGHT

**Appendix 5.E: Living Well after Breast Cancer extended contact intervention
updated week 12 tailoring telephone call participant profile sheet**

UPDATED PARTICIPANT PROFILE SHEET

FORTNIGHTLY REMINDER TO WEIGH SELF → ALL GET FORTNIGHTLY

TOTAL = 1 / FORTNIGHT

PHYSICAL ACTIVITY TEXTS: → CONVERT WEEKLY TO FORTNIGHTLY

TOTAL = / FORTNIGHT

HEALTHY EATING TEXTS: → CONVERT WEEKLY TO FORTNIGHTLY

TOTAL = / FORTNIGHT

PHYSICAL ACTIVITY GOAL CHECK TEXT:

☐

WEEKLY

OR

☐

FORTNIGHTLY

OR

☐

NONE

TOTAL = / FORTNIGHT

DIET GOAL CHECK TEXT:

☐

WEEKLY

OR

☐

FORTNIGHTLY

OR

☐

NONE

TOTAL = / FORTNIGHT

TOTAL MESSAGES = PER FORTNIGHT

**Appendix 6.A: Living Well after Breast Cancer extended contact intervention
participant information sheet**

Living Well after Breast Cancer – Follow-up Participant Information Sheet

Investigators: Lauren Spark - PhD Candidate, Cancer Prevention Research Centre, School of Population Health, The University of Queensland
Dr Marina Reeves – Senior Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland
Dr Brianna Fieldsoe - Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland
Professor Elizabeth Eakin – Director and Principal Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland

1. Why is the Living Well after Breast Cancer study continuing?

Thank you for participating in the first six months of the Living Well after Breast Cancer study. We hope you have found the program helpful in supporting you to make positive changes to your weight, eating habits, and exercise.

In order to get the most health benefit, it is important that you maintain these lifestyle changes over the long-term, so that they become lifelong habits. We are pleased to be able to offer you continued support for Living Well as part of the next phase of the study. This next phase will last for 12 months, during which time you will receive continued support for healthy eating and exercise from your Living Well Coach. Your Coach will provide this support via mobile phone text messages over the next six months. You will work with your Coach to decide exactly how many and what type of text messages you would like to receive.

This next phase of the Living Well after Breast Cancer study is being done as part of a PhD research project for Ms Lauren Spark. Your continued participation in this research will assist us in understanding how text messages can help women who have had breast cancer to maintain their weight loss and positive lifestyle changes.

2. What will happen if I decide to take part?

This study will last for 12 months and has five parts as explained below:

Part 1: Telephone counselling call with your Living Well Coach

After you complete your current six month health assessment, your Living Well Coach will call you to go through your results. This call should take approximately 45-60 minutes.

During this call, you will work with your Coach to set some further Living Well goals related to maintaining the changes you have made to your weight, eating habits, and exercise. Your Coach will also discuss with you your preferences for the types of text messages you would like to receive (see Part 2 below).

Part 2: Living Well text messages

You will receive text messages over the next six months. **How many, how often, when, and what the text messages say will be based on your personal preferences** (this will be discussed in the Part 1 telephone call with your Coach). These text messages will be designed specifically for you.

The text messages that you can choose to receive aim to:

- check whether you have reached your goals;
- remind you of something you have planned to do in order to reach your goals;
- provide you with extra support in challenging situations;
- provide helpful reminders and tips to encourage you to reach your goals; and
- remind you to think about and reset your goals

Examples of these messages can be seen on the attached 'Text Messages Information' sheet.

You will receive **at least one text message per fortnight** from your Coach that will check how you are going with reaching your goal, but you can choose to receive as few or as many of the other types of messages as you would like. **You can change the timing, frequency, or content of the text messages that you receive at any time.**

You will be asked to reply to some text messages, but it is up to you if you want to reply. Reply messages will be at your expense, based on your mobile phone charge rates. You do not need to have a lot of experience with using mobile phone text messaging, as long as you know how to read and send a text message.

Part 3: Check-in telephone call with your Living Well Coach

After you have received the text messages for 12 weeks, your Coach will call you to check that you are happy with the text messages you are receiving, and to help reassess your goals. This call will take approximately 15-30 minutes.

Part 4: Health assessments

You will be invited to attend two health assessments over the next 12 months: one in six months time (when the text messages will stop), and one in 12 months time. We will have no contact with you during the last six months of the program. The health assessments are the same as those you have already completed for the Living Well after Breast Cancer study. Each assessment has three parts:

1: In-person body measurement

You will be asked to attend the university research centre at Herston (near the Royal Children's Hospital) to complete a physical assessment where we will measure body weight, body composition, waist circumference, and lymphoedema status. This visit will take about 20-30 minutes. We will reimburse you for your travel (above 50km round trip) and any parking costs incurred.

2: Measuring your physical activity

During your visit to the university research centre, you will be given two small devices called activity monitors. You will be given an activity monitor to wear on a belt around your waist, and an activity monitor to wear on your thigh. We will ask you to wear the activity monitors for seven consecutive days while carrying out your normal daily activity routine. We will then ask you to return the activity monitors to us by mail in a pre-paid pack.

3: Answering questions about your health over the phone and by questionnaire

You will complete two telephone calls where we will ask you some questions about your diet and physical activity. The first call will take about 60-75 minutes, and the second call will take approximately 20-30 minutes. We will also give you a questionnaire to fill out and return to us by mail, or to complete electronically over the Internet. This will include questions about things that help you to be more physically active and eat a healthy diet, and how you feel about your body and your quality of life. The questionnaire will take about 30-45 minutes to complete.

You will receive printed feedback following each health assessment on your current weight, dietary intake, and physical activity levels.

Part 5: Feedback interview

As part of your health assessment in six months time, you will be invited to participate in a 20 minute feedback interview. In this feedback interview, we will ask questions about what you did and did not like about receiving the text messages, and how we could make the text messages better for other women in the future. This interview will be voice recorded, and will be conducted over the telephone or face-to-face, based on your preference.

3. What are the benefits to me if I take part?

We cannot guarantee that you will receive any personal benefit from participating in the study. We know that regular exercise and healthy eating may lead to improved short- and long-term health benefits, but we do not know how effective text messages will be in helping you to maintain the lifestyle changes you have made.

Your participation will provide us with valuable information to develop and improve this program to support women to maintain weight loss and lifestyle changes following a breast cancer diagnosis. Your participation may help other women who have breast cancer in the future.

4. What are the risks in taking part?

You may experience physical discomfort or muscle soreness as a result of exercising. However, the risks of involvement are not expected to be any greater than those faced by women doing physical activity in day-to-day living. Your Living Well Coach has worked with you before and will help you to set realistic exercise goals that are not likely to cause you injury or discomfort. You can stop taking part at any time, and it will not affect the health care you receive from your doctor.

5. Participation is voluntary

Taking part in this study is voluntary, if you do not wish to take part you do not have to. If you decide to take part and at a later stage change your mind, you are free to withdraw from the study at any time. Withdrawing from the study will not affect your relationship with The University of Queensland. If you do decide to withdraw, we would be grateful if you could notify a member of the research team.

6. Privacy & confidentiality

All information will be treated with the strictest confidence by the research team. You will be allocated an identification (ID) number so that your information can be stored in computer files without your name. Identifiable information (e.g., consent forms) will be stored in a locked filing cabinet accessible only by the investigators named above. All other data (paper and electronic) will only be identifiable by your ID number, and electronic files will be password-protected. You will not be identified in any reports or presentations that arise from the research. Your mobile phone telephone number will be kept confidential and not used for purposes other than participation in this study.

7. Results of project

At the completion of the study, you will receive a thank you letter and a summary of the research findings.

8. Who can I speak to if I have questions?

This study has been cleared by one of the Human Research Ethics Committees of The University of Queensland in accordance with the National Health and Medical Research Council's guidelines. You are free to discuss your participation in this study with project staff.

PhD Student: Lauren Spark, on 3365 5350, email: l.spark@uq.edu.au

Chief Investigator: Dr Marina Reeves, on 3346 4692, email: m.reeves@sph.uq.edu.au

If you would like to speak to an officer of the University not involved in the study, you may contact the Ethics Officer on 3365 3924. If you have any concerns about losing weight, changing your diet, or increasing your physical activity, please check with your doctor.

9. Final instructions

If you are interested in participating in the program, please sign the Consent Form attached. Please retain a copy of the Consent Form and Participant Information Sheet for your future reference.

**Appendix 6.B: Living Well after Breast Cancer extended contact intervention
text message example sheet**

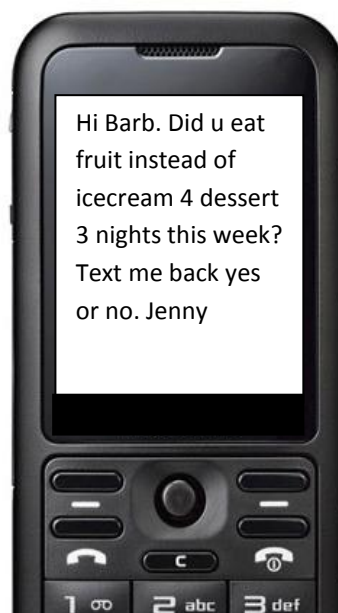
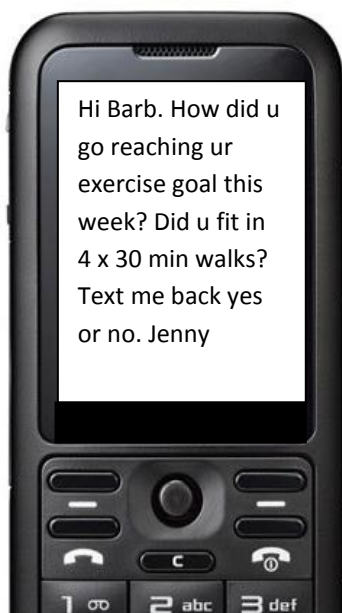
Living Well after Breast Cancer - Follow-up



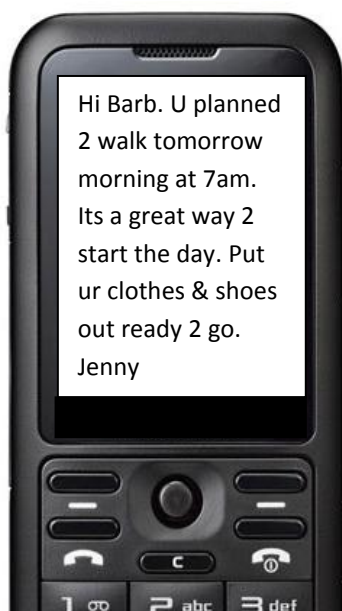
Text Message Information Sheet

Here are some examples of the text messages you may choose to receive:

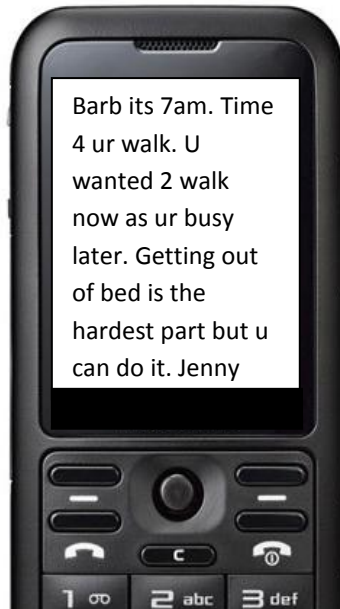
To check how you are going with reaching your goals...



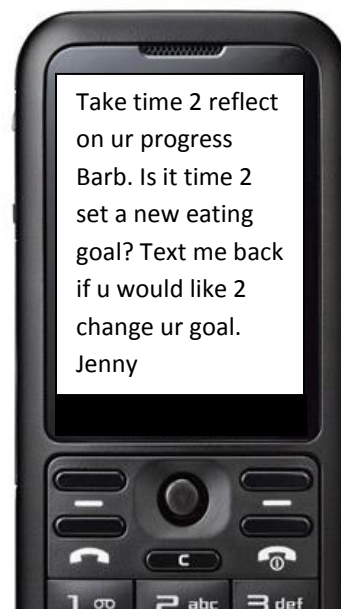
To remind you of what you have planned to do to reach your goals...



To provide you with extra support in challenging situations...



To remind you to think about and reset your goals...



**Appendix 6.C: Living Well after Breast Cancer extended contact intervention
participant consent form**

I,
Full Name

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Appendix 6.D: Living Well after Breast Cancer extended contact intervention quantitative feedback interview questions

PSM1. How helpful have you found receiving text messages over the last six months of the Living Well after Breast Cancer program?

1	2	3	4	5
Very unhelpful	Unhelpful	Neither helpful or unhelpful	Helpful	Very helpful

PSM2. When you received a text message over the last six months, what did you *normally* do with it?

- ☐ Read it and keep it for a bit (i.e., save or automatically store it)
- ☐ Read it then delete it immediately
- ☐ Not read it

PSM3. How often over the last six months did you re-read a text message at a later stage to motivate or remind you?

1	2	3	4	5
Never	Rarely	Sometimes	Often	Very often

Appendix 6.E: Living Well after Breast Cancer extended contact intervention qualitative feedback interview script

- The session will be recorded and any information shared in the session will be de-identified when reported will remain confidential.
- Start recording (state participant ID & date)
- My PhD is investigating whether extended contact via text messaging to maintain lifestyle changes is feasible and acceptable to women following a weight loss program. So the aim of this part of the study is to get as much feedback as possible about using text messaging to support women.
- Over the past six months you have received text messages from Amy/Jenny, and I want you to focus on these while I ask you some questions.
- Please don't be afraid to share any negative experiences you had with receiving the text messages as this is the first time this type of study has been done and all comments, be they positive or negative, are extremely helpful in determining how best to move forward.
- You are free to stop this interview at any point, and you are also free to not answer any questions which you do not feel comfortable answering.

Prior text message user

1. Before we started this study six months ago, would you say that you were a frequent text message user?
2. Did you receive any text messages from Amy/Jenny during the initial six months of the program when you were also receiving telephone calls?

Likes and dislikes

3. Overall how did you find the experience of receiving the text messages over the last six months?
4. What did you like most about receiving the text messages? (e.g., tailored, timing and frequency self-determined) *Why?*
5. Can you recall any specific messages you found most helpful or supportive? *Why?* (e.g., goal check, ones that encouraged me to focus on my goal)
6. What did you like the least about receiving the text messages? (e.g., the frequency, too repetitive) *Why?*

7. Can you recall any specific messages you found annoying or unhelpful? *Why?* (e.g., goal check because made frustrated as didn't achieve goal)

Usefulness of different types of texts

8. Do you think the text messages helped you to stay on track to reach your goals? *If yes, How? No, why?*
9. How useful was it to receive a text asking you whether you reached your goals?
10. On average, did you respond to these?
11. When you did respond, did you like that you received a reply to this message from Amy/Jenny? Would it have mattered if you didn't?
12. If you didn't reply, what was the most common reason for not replying back to this message?
13. How useful was it to receive a text reminding you to check your weight?

Tailoring of texts

14. How did you find the number of texts you received? (e.g., too many)
15. How did you find the timing of the texts you received?
16. In regards to the number of texts and timing you received them, were they what you asked for?
17. Did you send a text asking for the frequency or timing of the way you were receiving messages to be changed at any point? *Did making that change improve the helpfulness of the texts? If you didn't send a text asking to change this but you wanted to, why didn't you?* (e.g., too difficult, too hard to explain etc)
18. How did you find the language used in the text messages?
19. Was the abbreviation of words ok?
- You (u); Be (b); To (2); Your (ur); See (c)
20. Did you feel the content of the messages were sufficiently personalised to you? How?
21. To what extent did the content of the messages you received over the last six months feel relevant to your situation?
22. Did the consistency with which you read text messages change over the last six months? (e.g., read more at beginning and less at the end)
23. On average over the last six months, what percentage of the time would you say you *didn't* read a text message?

12-week check in call

24. At any point over the last six months did you wish you could just talk to Amy/Jenny?
25. To what extent did you find the telephone call half way through the last 6 months useful?
26. Would you have been happy to continue contact via text only or do you think it was important to be able to talk to Amy or Jenny at that point?

Future suggestions

27. Do you have any suggestions about how to improve the text messages so that they would be more helpful to women following the first part of the LWaBC program?
28. Do you have any other feedback or comments about what you liked or disliked, or any comments about your experiences with receiving the text messages over the last six months?

Appendix 7.A: Living Well after Breast Cancer questionnaire completed at baseline, 6-, 12-, and 18-months



ID: _____

Participant Questionnaire

Instructions

- Please answer all the parts of this questionnaire. If you are not sure about your answer, please give your best estimate. If you are uncomfortable in answering any question, you can leave it blank.
- Please respond to each question by ticking the box that corresponds to your answer. Please only select one response option for each question. If you need to change your response please clearly cross out the wrong response option.
- Throughout this questionnaire we refer to 'diet', 'healthy foods', and 'unhealthy foods'. By these terms we mean:

Diet – refers to all of the foods and drinks you consume during the day

Healthy foods – includes foods like fruits, vegetables, wholegrain products, lean meats, fish, raw nuts, eggs, low fat dairy foods, and generally foods that are low in fat and/or low in sugar.

Unhealthy foods – includes foods that are high in energy, fat and/or sugar like cakes, biscuits, lollies, chocolate, crisps, hot chips, pastries, pies, take-away foods, soft drinks, and desserts.

- We will also frequently refer to your 'current level of exercise'. Please answer all of these questions even if you do not currently exercise.
- The questionnaire should take between 30-45 minutes to complete.
- All information you provide in this questionnaire will be treated with the strictest confidence by the Living Well after Breast Cancer team.
- Once you have completed the questionnaire, please return it to us in the reply paid envelope provided.

Thank you for taking the time to complete this questionnaire.

This study is being conducted by

<u>Dr Marina Reeves:</u>	Senior Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland
<u>Professor Elizabeth Eakin:</u>	Director and Principal Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland
<u>Dr Sandi Hayes:</u>	Senior Research Fellow, School of Public Health, Institute of Health and Biomedical Innovation, Queensland University of Technology
<u>Associate Professor Nicole McCarthy:</u>	Medical Oncologist, Haematology & Oncology Clinics of Australia; Royal Brisbane and Women's Hospital
<u>Dr Sheleigh Lawler:</u>	Research Fellow, Cancer Prevention Research Centre, School of Population Health, The University of Queensland
<u>Dr Ingrid Hickman:</u>	Senior Research Officer, Diamantina Institute, The University of Queensland
<u>Professor Wendy Demark-Wahnefried:</u>	Associate Director, Comprehensive Cancer Centre, University of Alabama at Birmingham, USA

and is supported by Breast Cancer Network of Australia

*If you have any questions when completing this questionnaire,
please contact Jane Masters on 3365 5190.*

PART A**I believe that eating a healthy diet will lead to....**

		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1.	Weight loss	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
2.	Feeling good	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
3.	Feeling less bloated	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
4.	Prevention or control over diseases like heart disease or diabetes	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
5.	Reduced risk of breast cancer returning	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
6.	More energy	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
7.	Improved physical health	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
8.	Regular and healthy bowels	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
9.	Feeling hungry	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
10.	Spending more money on food	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
11.	Missing out on my favourite foods	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
12.	Feeling tired	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

I believe that engaging in regular exercise will lead to....

		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
13.	Improved mental wellbeing	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
14.	Lower stress levels	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
15.	More energy	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
16.	Increased confidence	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
17.	Improved physical health	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
18.	Reduced risk of breast cancer returning	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
19.	Feeling good immediately after exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
20.	Weight loss	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
21.	Injury	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

22.	Sore muscles or joints	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
23.	Feeling tired	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
24.	Having less time to do other things	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

PART B

Please indicate the extent to which you agree or disagree with the statement:

		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
1.	I am satisfied that my current diet has helped me to lose weight	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
2.	I am satisfied that my current diet makes me feel good	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
3.	I am satisfied that my current diet makes me feel less bloated	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
4.	I am satisfied that my current diet helps to prevent or control my risk of diseases like heart disease or diabetes	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
5.	I am satisfied that my current diet helps to reduce the risk of breast cancer returning	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
6.	I am satisfied that my current diet gives me more energy	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
7.	I am satisfied that my current diet helps to improve my physical health	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
8.	I am satisfied that my current diet gives me regular and healthy bowels	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
9.	I am satisfied that my current diet does NOT make me feel hungry	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
10.	I am satisfied that my current diet does NOT lead to spending more money on food	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
11.	I am satisfied that my current diet does NOT cause me to miss out on my favourite foods	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
12.	I am satisfied that my current diet does NOT make me feel tired	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Please indicate the extent to which you agree or disagree with the statement:

		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
13.	I am satisfied that my current level of exercise improves my mental wellbeing	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
14.	I am satisfied that my current level of exercise lowers my stress levels	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
15.	I am satisfied that my current level of exercise gives me more energy	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
16.	I am satisfied that my current level of exercise gives me more confidence	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
17.	I am satisfied that my current level of exercise helps improve my physical health	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
18.	I am satisfied that my current level of exercise helps to reduce the risk of breast cancer returning	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
19.	I am satisfied that my current level of exercise makes me feel good immediately after exercising	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
20.	I am satisfied that my current level of exercise helps me to lose weight	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
21.	I am satisfied that my current level of exercise has NOT caused me injury	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
22.	I am satisfied that my current level of exercise does NOT give me sore muscles or joints	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
23.	I am satisfied that my current level of exercise does NOT make me feel tired	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
24.	I am satisfied that my current level of exercise does NOT take time away from doing other things	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Please indicate the extent to which you agree or disagree with the statement:

		Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
25.	I enjoy exercising	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

PART C

The next questions are about how often you used various strategies to help you eat healthy foods.

In the past month....

		Never	Rarely	Some- times	Often	Very often
1.	I thought about what I was eating	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
2.	I recorded the food I ate in a written record	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
3.	I recorded the food I ate in a written record, including portion size and kilojoule (calorie) count	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
4.	I paid attention to why I was eating (e.g. for hunger or other reason – stressed, watching TV)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
5.	I set short-term dietary goals (daily or weekly)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
6.	I set long-term dietary goals (monthly or longer)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
7.	I set goals for specific meals or times of the day (e.g. I will eat two cups of vegetables with dinner)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
8.	I thought about my dietary goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
9.	I wrote down my dietary goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
10.	I rewarded myself for meeting my dietary goals (e.g. bought myself a gift)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
11.	I rewarded myself for reaching my goals related to healthy eating (e.g. weight loss)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
12.	I reminded myself of the health benefits of healthy eating (e.g. lose weight, have more energy)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
13.	I reminded myself of the risks of NOT eating healthily (e.g. increased risk of heart disease, weight gain)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

In the past month....

		Never	Rarely	Some- times	Often	Very often
14.	I planned ahead for what meals/foods I would eat over the week	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
15.	I did my grocery shopping ahead of time so that I had healthy foods to eat/prepare	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
16.	I paid attention to barriers which got in the way of my dietary goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
17.	I planned ways to overcome barriers to my dietary goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
18.	I wrote down barriers that got in the way of my dietary goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
19.	I wrote down ways to overcome barriers to my dietary goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

The next questions are about how often you used various strategies to help you exercise.

In the past month....

		Never	Rarely	Some- times	Often	Very often
20.	I thought about my exercise activities	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
21.	I recorded my exercise activities in a written record, including duration and intensity of my exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
22.	I paid attention to specific things to help me exercise regularly (e.g. I have more energy in the morning so I made sure I exercised then)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
23.	I set short-term goals (daily or weekly) related to how often I exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
24.	I set long-term goals (monthly or longer) related to how often I exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
25.	I set goals for exercise time or distance (e.g. swim 20 minutes, walk 3km)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
26.	I thought about my exercise goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
27.	I wrote down my exercise goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

In the past month....

		Never	Rarely	Some- times	Often	Very often
28.	I rewarded myself for reaching my exercise goals	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
29.	After I exercised, I focused on how good I felt	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
30.	I reminded myself of health benefits of exercise (e.g. lose weight, have more energy)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
31.	I reminded myself of the risks of NOT exercising (e.g. heart disease, weight gain)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
32.	I scheduled specific times to exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
33.	I wrote down specific times to exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
34.	I rearranged my schedule to be sure I had time to exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
35.	If I had conflicts with my scheduled exercise time, I chose exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
36.	I paid attention to barriers which got in the way of my exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
37.	I planned ways to overcome barriers to my exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
38.	I wrote down barriers that got in the way of my exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
39.	I wrote down ways to overcome barriers to my exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

PART D**How confident are you that you would be able to choose healthy food options when....**

		Not at all confident	Slightly confident	Somewhat confident	Confident	Extremely confident
1.	you are in a bad mood (e.g. anxious, depressed or irritable)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
2.	you are bored	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
3.	on the weekends	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
4.	you are at a party or out to dinner with family or friends	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
5.	there are many appealing unhealthy foods available	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
6.	you are on holidays	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
7.	you are tired	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

How confident are you that you would be able to exercise when....

		Not at all confident	Slightly confident	Somewhat confident	Confident	Extremely confident
8.	you get very busy	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
9.	it interferes with spending time with your family or friends	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
10.	you are sore or tired	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
11.	you are in a bad mood (e.g. anxious, depressed or irritable)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
12.	there is housework to do	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
13.	you are on holidays	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
14.	the weather is bad (e.g. raining, too hot, too cold)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

How confident are you that you....

		Not at all confident	Slightly confident	Somewha t confident	Confident	Extremely confident
15.	can lose weight	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
16.	can lose weight through regular exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
17.	can lose weight through healthy eating	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
18.	can do the things you need to to lose weight	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

PART E

During the past month, how often have your friends, family, or members of your household....

		Never	Rarely	Some- times	Often	Very Often
1.	encouraged you not to eat unhealthy foods when you were tempted to do so?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
2.	discussed your diet with you? (i.e., How are you going with your diet?)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
3.	reminded you not to eat unhealthy foods?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
4.	complimented you on eating healthy foods?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
5.	commented if you went back to your old eating habits?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
6.	eaten unhealthy foods in front of you?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
7.	refused to eat the same healthy food as you eat?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
8.	brought home foods you were trying NOT to eat?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
9.	got angry when you encouraged them to eat healthy foods?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
10.	offered you food that you were trying NOT to eat?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

During the past month, how often have your friends, family, or members of your household....

		Never	Rarely	Some- times	Often	Very Often
11.	exercised with you?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
12.	given you helpful reminders to exercise? (e.g. Are you going for a walk tonight?)	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
13.	given you encouragement to stick with your exercise program?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
14.	changed their schedule so you could exercise together?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
15.	discussed exercise with you?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
16.	complained about the time you spend exercising?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
17.	criticised you or made fun of you for exercising?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
18.	given you rewards for exercising?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
19.	planned for exercise on recreational outings?	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
20.	helped plan activities around your exercise	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

PART F

The next questions are about aspects of your neighbourhood that might influence whether or not you exercise. By 'neighbourhood' we mean the places around your home that you could walk to in **10-15 minutes**.

Please indicate the extent to which you agree or disagree with each of the following statements:

		Strongly Disagree	Disagree	Not Sure	Agree	Strongl y Agree
1.	My neighbourhood has many shops or other places to buy things I need	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
2.	My home is within a 10-15 minute walk to a bus stop or train station	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
3.	There are footpaths on most of the streets in my neighbourhood	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
4.	My neighbourhood has several free or low cost recreation facilities, such as parks, walking paths, playgrounds, public swimming pools etc.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
5.	The crime rate in my neighbourhood makes it unsafe to exercise at night	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
6.	There is so much traffic on the streets that it makes it difficult or unpleasant to exercise in my neighbourhood	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
7.	I see many people exercising in my neighbourhood doing things like walking, jogging, cycling or playing sport	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
8.	There are many interesting things to look at while exercising in my neighbourhood	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Please indicate the extent to which you agree or disagree with each of the following statements:

		Strongly Disagree	Disagree	Not Sure	Agree	Strongl y Agree
9.	Where I shop has a large selection of fresh fruit and vegetables	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
10.	Where I shop has a large selection of tinned or frozen fruit and vegetables	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
11.	Where I shop has a large selection of low fat products	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
12.	Where I go for takeaway has a large selection of healthy options	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
13.	Where I shop has affordable fresh fruit and vegetables	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
14.	Where I shop has affordable tinned or frozen fruit and vegetables	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
15.	Where I shop has affordable low fat products	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅
16.	Where I go for takeaway has affordable healthy options	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄	<input type="checkbox"/> ₅

Thank you very much for taking the time to complete this survey. Please send the survey back in the reply-paid envelope supplied as soon as you can.

Appendix 7.B: Adaptation of measures used in Living Well after Breast Cancer questionnaire

Construct	Adaptions & Modifications
Self-efficacy	<p>PA: The questions were slightly adapted from Linde and colleagues' (2006) original 5-item measure. The last question in the Linde measure 'exercise when you are bored with your current exercise plan' was replaced with 'when there is housework to do'. Two additional items were added: 'when you are on holidays' and 'when the weather is bad (e.g., raining, too hot, too cold)'. The response scale was modified from a 9-point scale (0 = not at all confident; 8 = extremely confident) to a 5-point scale to simplify and ensure continuity of the response scales across the questionnaire. This measure of self-efficacy was used instead of other measures of self-efficacy for physical activity previously used in cancer survivor populations as the questions are were similar, but these other measures were longer (i.e., 9items) and asked questions that overlapped with other constructs, such as social support (e.g., confidence in ability to exercise when I do not have someone to encourage me to exercise) and general self-efficacy (e.g., confidence to exercise when lack discipline) rather than specifically related to physical activity self-efficacy. Linde and colleagues (2006) used a 5-item measure of physical activity self-efficacy which clearly identified barriers that have been specifically identified as pertinent in the physical activity maintenance literature, and for this reason it was considered the most succinct and relevant measure (i.e., short) of physical activity self-efficacy to use.</p> <p>DIET: The diet self-efficacy questions were modified from the original 5-item from Linde and colleague's (2006) diet barrier self-efficacy scale. One item was changed: 'from 'when many appealing high calorie (high energy) foods are available' to 'when many appealing unhealthy foods are available'. These questions stayed the same: 'when you are bored'; 'when you are in a bad mood (e.g., anxious, depressed or irritable)'; 'on the weekends'; 'when you are at a party or out to dinner with friends or family'.</p>
Self-regulation	<p>Self-regulation of physical activity contained 20 items and self-regulation of diet contained 19 items. These items were modified from Petosa's (1993) original 43-item questionnaire assessed the degree to which self-regulation strategies were used to support physical activity adoption and maintenance. The diet self-regulation questions were modelled from the physical activity questions as no measure to our knowledge existed to measure diet self-regulation strategies. The original sub-scales were: self-monitoring (5 items), goal setting (9 items), social support (9 items), reinforcement (9 items), time management (4 items), and relapse prevention (7 items). For both behaviours, the social support scale was removed as social support for both behaviours were measured in the separate social support construct. The items were categorised into the same sub-scales (except for social support) but the wording of the items changed to increase clarity, comprehension, and made sense given the intervention strategies that were taught to participants during the weight-loss intervention (e.g., keeping a written record of food eaten including portion size and kilojoule count). PA items were condensed to shorten the length of the questionnaire, to include: self-monitoring (3 items), goal setting (5 items), reinforcement (4 items), time management (4 items), and relapse prevention (4 items). The diet sub-scales for the 19 items were: self-monitoring (4 items), goal setting (5 items), reinforcement (4 items), time management (2 items), and relapse prevention (4 items).</p>

Social support	<p>Social support for physical activity was measured using a modified version of Sallis and colleagues' (1987) Social Support for Exercise Scale. This measure was designed to assess the frequency of family and friend support for physical activity over the last three months. The measure was shortened from 36 diet questions and 29 physical activity questions to 10 items for each of diet and physical activity (total = 20). The questionnaire was adapted to ask about support received from 'friends, family, or members of your household' combined, instead of asking separately for support for 'friends' and from 'family' to shorten the measure and gain an overall score for social support. The recall time frame was also adjusted from three months to one month given three months was judged by the research team as too difficult to accurately recall or estimate.</p>
Perceived environmental opportunity	<p>PA: Items derived from the Modified International Prevalence Study on Physical Activity – Environmental Module (IPS-E). Questions 2-10 were adapted for Australian language (e.g., sidewalks changed to footpaths). The questions were also asked about exercise, not just walking as in the original measure. This was changed as women may choose to do other activities besides walking for exercise in their neighbourhood (e.g., cycling).</p> <p>DIET: Given there are no measures to our knowledge for perceived environment for healthy eating, a measure was created. The 8 item measure was modelled on the existing measures of food choice and affordability (Didsdall et al., 2003) and perceived availability of healthy foods in neighbourhood (Moore et al., 2008), with modifications that included questions on neighbourhood takeaway perceptions.</p>
Outcome expectancy	<p>PA: The specific PA outcomes used in this measure were determined from formative research with breast cancer patients (Rogers et al., 2004). The five most commonly reported positive PA outcomes from this formative work were used in this measure (i.e., more energy; improved mental wellbeing; lower stress levels; increased confidence; feeling good immediately after exercise). Four negative PA outcomes (i.e., possible injury; sore muscles or joints; feeling tired; having less time to do other things) were also measured because outcome expectancies are thought to be better predicted when both positive & negative outcomes are considered (Williams et al., 2005). These negative outcomes were similar to those previously reported as negative exercise expectations in breast cancer survivors (injury not included). The 'longevity of life' outcome was replaced with 'improved physical health' given this outcome was more applicable to be also used in the satisfaction construct. 'Reduced risk of breast cancer returning' and 'weight loss' were added as positive outcomes given the context that participants enrolled in a weight loss study as breast cancer survivors.</p> <p>DIET: The outcomes expectancy items in the diet measure were adapted from Zunft and colleagues (1997) who determined the perceived benefits of healthy eating among European adults (i.e., stay healthy, prevent disease, control weight, be fit, quality of life, look attractive, live longer, more energy, do well at sport). Modifications included: modified 'prevent disease' to 'prevention or control over diseases like heart disease or diabetes' (given the overweight or obese sample population that may have existing medical conditions); combined 'be fit', 'quality of life' and 'stay healthy' to 'improved physical health'; changed 'control weight' to 'lose weight' (given nature of weight loss intervention); removed 'live longer' as this not able to be assessed in satisfaction construct; changed 'look attractive' to 'feeling good'; removed 'do well at sport' as not applicable to sample group. Positive (i.e., feeling less bloated; reduced risk of breast cancer returning; regular and healthy bowels) and negative outcomes (i.e., feeling hungry; spending more money on food; missing out of favourite foods; feeling tired) thought to be important outcome expectations for diet in this sample were added.</p>

Satisfaction with outcomes	<p>Only a handful of studies assess satisfaction with physical activity and have assessed satisfaction with one outcome (e.g., weight loss; i.e., given the effort you have put into following your weight control plan, how satisfied are you with the amount you have either lost or gained during the past month?). A study by Courneya and colleagues (2006) most closely to the objectives of our study evaluated the perceived benefits of an exercise program, but did not assess satisfaction per se with these achievements (i.e., If you were to do the aerobic exercise training program I would likely relieve stress, improve energy level etc; scale 1-7 extremely unlikely; extremely likely) followed by evaluation of whether these expectations were achieved (i.e., Did the aerobic exercise training program help you to relieve stress, improve energy levels etc; scale 1-7 not at all; very much). It is plausible to assume that even if benefits were achieved, they were not as great as originally expected. Given the theoretical basis that the constructs of outcome expectancy and satisfaction are linked, the current study used one question per outcome expectancy item to explicitly measure satisfaction of experiencing each physical activity (e.g., I am satisfied that my current level of exercise improves my mental wellbeing) and dietary (e.g., I am satisfied that my current diet has helped me to lose weight) outcome. The response scale consisted of a 5-point agreement scale (1=strongly disagree; 2=disagree; 3=not sure; 4=agree; 5=strongly agree).</p>
Enjoyment for physical activity	<p>Previous studies have used multiple questions to assess enjoyment for activity, but questions were very similar (e.g., I enjoy being physically active; I find being physically active pleasurable; Being physically active is very pleasant; Being physically active is very exciting). In anticipation of asking very similar questions and being confusing and annoying for participants, the current study used a single-item that simply defined the concept of enjoyment of physical activity (i.e., I enjoy exercising). A similar single-item approach to measuring physical activity enjoyment has been used in prior studies with breast cancer survivors (Rogers et al., 2005).</p>

Appendix 7.C: Living Well after Breast Cancer baseline demographic and health-related questions

DEMOGRAPHICS AND HEALTH INFORMATION

The next questions collect some general information about you so we can describe the group of women who have participated in Living Well after Breast Cancer. All information will be kept strictly confidential.

DE1 What is your current age? _____ years of age

DE2* Has your doctor ever told you that you have any of the following health conditions?

1. Heart disease
2. High blood pressure
3. High cholesterol/Hyperlipidemia
4. Stroke
5. Arthritis (Osteo or Rheumatoid)
6. Lung disease (Emphysema, Asthma, Chronic Bronchitis)
7. Osteoporosis
8. Cancer (excluding breast cancer) – *specify type* _____
9. Depression
10. Anxiety/Nervous disorder
11. Other mental health condition – *specify* _____
12. None of these

DE3 In the last 6 months have you used any of the following to help with weight loss? [Multiple responses allowed]

1. Meal replacements** such as Tony Ferguson, Optifast or Slimfast
2. Food delivery weight loss programs such as Jenny Craig or Lite n' Easy
3. Other weight loss programs such as Weight Watchers
4. Bariatric (weight loss) surgery such as gastric banding
5. Weight loss medications such as Xenical or Reductil
6. None

Interviewer clarification: If the participant had been using meal replacements (selects option 1) then please ensure that you record their actual intake of meal replacement products on the manual response sheet.

DE4 Have you ever smoked at least 100 cigarettes in your entire life?

1. Yes
2. No (**go to DE6**)
3. Don't know/not sure (**go to DE5**)

DE5 Do you now smoke cigarettes every day, some days or not at all?

1. Every day
2. Some days
3. Not at all

DE6 In which country were you born?

1. Australia
2. Country other than Australia

DE7 Do you speak a language other than English at home?

1. Yes
2. No (go to DE8)

What language (other than English) is spoken at home? _____

DE8 How would you describe your ethnic origin? (*Ethnicity is how you see yourself, it is a mixture of culture, religion, skin colour, language, the origins of yourself and your family. It is not the same as nationality.*)

1. Caucasian or white (Australian, European, White American, Canadian, White South African)
2. Aboriginal or Torres Strait Islander
3. Asian (Originated from: Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand, Vietnam, China, Hong Kong, Japan, Korea, Afghanistan, India, Nepal, Pakistan, Sri Lanka)
4. Middle Eastern (Originated from Israel, Iran, Iraq, Lebanon, Turkey, Egypt or Arab)
5. Pacific Islander (South Sea Islander, Samoan, New Zealand Maori or originated from the Pacific Islands, Hawaii, New Guinea)
6. South American of Spanish/Latino descent (originated from Mexico, Central or South America)
7. Other – *please specify* _____

DE9 What is your present marital status?

1. Married/living together
2. Divorced
3. Married but separated
4. Widowed
5. Never married

DE10 How many children aged under 18 years live in your household?

_____ children

DE11 From the following list, which is the highest education level you have obtained?

1. Did not complete primary school or have no formal schooling
2. Completed primary school (Grade 7, age 12-13)
3. Completed high school through to Grade 10 (age 15-16)

4. Completed high school through to Grade 12 (age 17-18)
5. Completed a trade or technical certificate or diploma (includes enrolled nurses, but not registered nurses)
6. Completed an undergraduate university degree
7. Completed a postgraduate diploma
8. Completed a masters degree or doctorate
9. Other – *please specify* _____

DE12 Which one of the following best describes your main current employment situation?

1. Full time paid work
2. Part time paid work
3. Casual paid work
4. Home duties and not looking for work
5. Retired
6. Unable to work
7. Unemployed – looking for work
8. Student
9. Other – *please specify* _____

For the final question, I will be asking you about your combined household income. If you choose not to answer this question that is perfectly fine. However I will let you know that the categories used to respond to this question are quite broad. *[proceed unless participant states that they don't wish to answer question]*

DE13 APPROXIMATELY what is your combined household income (received by ALL members of your household) per week before tax?

1. Less than or equal to \$540 per week (less than or equal to \$28,080 per year)
2. \$541 - \$1,007 per week (\$28,081 - \$52,364 per year)
3. \$1,008 - \$1,577 per week (\$52,365 - \$82,004 per year)
4. \$1,578 - \$2,390 per week (\$82,005 - \$124,280 per year)
5. Greater than or equal to \$2,391 per week (greater than or equal to \$124,281 per year)
6. I don't know
7. I don't know my before tax household income but I know my after tax household income is approximately \$..... per week / per fortnight / per year (*write down approximate amount and circle what time period*)
8. I don't want to answer this question

BREAST CANCER INFORMATION

The following questions I'm going to ask you relate to your breast cancer.

BC1 At the time of being diagnosed with breast cancer, were you pre-menopause, currently going through menopause or post-menopause?

1. Pre-menopause
2. Currently going through menopause
3. Post-menopause

BC2 What treatments have you undertaken for your breast cancer?

1. Surgery

2. Chemotherapy
3. Radiation therapy
4. Hormone therapy
5. Herceptin
6. Other (please specify) _____

Interviewer clarification: please list ALL treatments undertaken

BC3 When did you finish your final treatment for breast cancer? (*excludes Hormone therapy, Herceptin*)

1. < 1 month ago
2. 1-2 months ago
3. 3-4 months ago
4. 5-6 months ago
5. 7-8 months ago
6. 9-10 months ago
7. 11-12 months ago
8. More than 12 months ago
9. Date (*if known*): ____/____/____

BC4 Have you undertaken breast reconstruction surgery?

1. No
2. Yes
3. Planned (date of surgery if known) ____/____/____

BC5 Since diagnosis of your breast cancer, have you been diagnosed with lymphoedema (swelling) in the arm, breast or trunk?

Interviewer clarification: please list ALL applicable locations

1. Yes, right arm
2. Yes, left arm
3. Yes, right trunk
4. Yes, left trunk
5. Yes, right breast
6. Yes, left breast
7. No (***if No skip to DE1***)

(If yes), when were you first diagnosed? _____ (month) / _____ (year)
And who diagnosed you (for example, surgeon, oncologist) _____

BC6 How would you characterise this lymphoedema?

1. Single episode (had it but now resolved)
2. Recurrent (it comes and goes)
3. Persistent (almost always there)

BC7 Do you currently, that is right now, have lymphoedema?

1. No
2. Yes

Appendix 7.D: Mean standardised changes in physical activity-related constructs from baseline and between the follow-up timepoints

	Baseline	6MΔ ^a		12 MΔ ^a		18 MΔ ^a		12MΔ-6MΔ ^b		18MΔ-12MΔ ^b	
	Mean ±SD	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p
Outcome expectancy	3.85 ± 0.43	0.46 (0.25, 0.68)	<0.001	0.62 (0.38, 0.85)	<0.001	0.27 (0.03, 0.50)	0.027	0.15 (-0.17, 0.48)	0.572	-0.35 (-0.69, -0.01)	0.048
Satisfaction with outcomes	3.38 ± 0.64	0.93 (0.39, 1.17)	<0.001	0.81 (0.55, 1.07)	<0.001	0.72 (0.45, 0.99)	<0.001	-0.12 (-0.59, 0.34)	0.883	-0.09 (-0.58, 0.40)	0.955
Self-regulation	2.34 ± 0.60	1.19 (0.87, 1.50)	<0.001	0.73 (0.39, 1.07)	<0.001	0.61 (0.26, 0.95)	<0.001	-0.46 (-0.95, 0.03)	0.071	-0.12 (-0.64, 0.39)	0.915
Self-efficacy	2.56 ± 0.93	0.90 (0.60, 1.20)	<0.001	0.72 (0.41, 1.03)	<0.001	0.52 (0.21, 0.83)	0.002	-0.18 (-0.42, 0.07)	0.223	-0.20 (-0.46, 0.05)	0.143
Social support	2.64 ± 0.77	-0.06 (-0.18, 0.31)	0.604	-0.03 (-0.89, 0.24)	0.850	0.06 (-0.18, 0.31)	0.604	-0.09 (-0.46, 0.29)	0.915	0.01 (-0.40, 0.40)	1.000
Perceived environment	3.75 ± 0.80	-0.02 (-0.22, 0.17)	0.802	0.04 (-0.16, 0.25)	0.668	0.019 (-0.19, 0.23)	0.856	0.07 (-0.20, 0.33)	0.895	-0.03 (-0.30, 0.25)	0.994
Enjoyment	4.14 ± 0.85	0.02 (-0.23, 0.28)	0.864	0.28 (0.01, 0.55)	0.041	-0.21 (-0.48, 0.07)	0.140	0.26 (-0.15, 0.66)	0.322	-0.48 (-0.90, -0.07)	0.018

^a Mean standardised changes from baseline (units = 1 standard deviation as reported in the table), estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

^b Differences in mean standardised change between follow-up timepoints (units = 1 standard deviation as reported in the table), estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

Appendix 7.E: Mean standardised changes in diet-related constructs from baseline and between the follow-up timepoints

	Baseline	6MΔ ^a		12 MΔ ^a		18 MΔ ^a		12MΔ-6MΔ ^b		18MΔ-12MΔ ^b	
	Mean ±SD	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p
Outcome expectancy	3.91 ± 0.35	0.31 (-0.01, 0.62)	0.053	0.48 (0.15, 0.81)	0.006	0.21 (-0.13, 0.55)	0.220	0.17 (-0.30, 0.64)	0.738	-0.27 (-0.76, 0.22)	0.446
Satisfaction with outcomes	3.36 ± 0.47	1.15 (0.23, 1.48)	<0.001	0.86 (0.50, 1.21)	<0.001	0.90 (0.54, 1.26)	<0.001	-0.29 (-0.83, 0.24)	0.451	0.04 (-0.52, 0.61)	0.997
Self-regulation	2.38 ± 0.55	1.45 (1.10, 1.81)	<0.001	0.61 (0.23, 0.99)	0.002	0.57 (0.19, 0.96)	0.004	-0.84 (-1.38, -0.31)	0.001	-0.04 (-0.60, 0.53)	0.998
Self-efficacy	2.66 ± 0.92	0.67 (0.39, 0.96)	<0.001	0.62 (0.33, 0.92)	<0.001	0.60 (0.30, 0.91)	<0.001	-0.05 (-0.37, 0.28)	0.978	-0.02 (-0.36, 0.32)	0.998
Social support	2.63 ± 0.52	0.47 (0.13, 0.81)	0.008	0.34 (-0.02, 0.69)	0.061	0.79 (0.42, 1.16)	<0.001	-0.13 (-0.54, 0.28)	0.814	0.45 (0.01, 0.89)	0.042
Perceived environment	3.97 ± 0.56	0.09 (-0.16, 0.35)	0.460	0.09 (-0.19, 0.36)	0.541	0.25 (-0.04, 0.53)	0.085	-0.01 (-0.44, 0.43)	1.000	0.16 (-0.29, 0.62)	0.763

^a Mean standardised changes from baseline (units = 1 standard deviation as reported in the table), estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

^b Differences in mean standardised change between follow-up timepoints (units = 1 standard deviation as reported in the table), estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

Appendix 7.F: Overall associations and timepoint interactions of changes from baseline in physical activity-related constructs with changes in physical activity, and differences in these associations between the follow-up timepoints

	Overall association		Timepoint interaction	6MΔ ^a		12 MΔ ^a		18 MΔ ^a		12MΔ-6MΔ ^b		18MΔ-12MΔ ^b	
	β (95% CI)	p	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p
Outcome expectancy	5.97 (0.90, 11.04)	0.022	<0.001	4.43 (-1.30, 10.16)	0.127	1.39 (-4.84, 7.61)	0.657	17.55 (10.20, 24.89)	<0.001	-3.04 (-9.72, 3.63)	0.362	16.16 (8.73, 23.59)	<0.001
Satisfaction with outcomes	3.94 (-3.12, 8.20)	0.069	0.912	-		-		-		-		-	
Self-regulation	3.91 (-0.29, 8.11)	0.067	0.749	-		-		-		-		-	
Self-efficacy	7.50 (1.86, 13.13)	0.011	0.536	6.16 (-0.99, 13.31)	0.090	6.43 (-1.13, 13.99)	0.094	10.52 (2.78, 18.25)	0.009	0.27 (-8.47, 9.00)	0.951	4.09 (-4.88, 13.06)	0.362
Social support	4.03 (-2.50, 10.55)	0.221	0.317	-		-		-		-		-	
Perceived environment	7.16 (-0.87, 15.19)	0.079	<0.001	0.06 (-8.58, 8.70)	0.989	-1.72 (-13.17, 9.72)	0.764	23.16 (12.98, 33.33)	<0.001	-1.78 (-13.82, 10.25)	0.766	24.88 (11.74, 38.02)	<0.001
Enjoyment	2.36 (-3.07, 7.78)	0.387	0.225	-		-		-		-		-	

^a Association of changes from baseline (units = 1 standard deviation of psychosocial variable associated with mins/day as reported in the table), estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

^b Differences between follow-up timepoints in association of changes from baseline (units = 1 standard deviation of psychosocial variable associated with mins/day as reported in the table), estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

Appendix 7.G: Overall associations and timepoint interactions of changes from baseline in diet-related constructs with changes in energy intake, and differences in these associations between the follow-up timepoints

	Overall association		Timepoint interaction	6MΔ ^a		12 MΔ ^a		18 MΔ ^a		12MΔ-6MΔ ^b		18MΔ-12MΔ ^b	
	β (95% CI)	p	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p
Outcome expectancy	-32 (-467, 403)	0.882	0.697	-		-		-		-		-	
Satisfaction with outcomes	-171 (-506, 164)	0.308	0.721	-		-		-		-		-	
Self-regulation	-10 (-414, 394)	0.959	0.174	-		-		-		-		-	
Self-efficacy	-303 (-782, 174)	0.204	0.413	-		-		-		-		-	
Social support	-422 (-842, -3)	0.049	0.559	-218 (-812, 374)	0.463	-480 (-1100, 140)	0.127	-686 (-1447, 75)	0.076	-261 (-1081, 559)	0.524	-206 (-1150, 738)	0.660
Perceived environment	-292 (-725, 139)	0.179	0.485	-		-		-		-		-	

^a Association of changes from baseline (units = 1 standard deviation of psychosocial variable associated with kJ/day of energy intake as reported in the table), estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

^b Differences between follow-up timepoints in association of changes from baseline (units = 1 standard deviation of psychosocial variable associated with kJ/day of energy intake as reported in the table), estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

Appendix 7.H: Overall associations and timepoint interactions of baseline demographic and health-related characteristics with changes in physical activity, and differences in these associations between the follow-up timepoints

	Overall association		Timepoint interaction	6MΔ ^a		12 MΔ ^a		18 MΔ ^a		12MΔ-6MΔ ^b		18MΔ-12MΔ ^b	
	β (95% CI)	p		Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p		
<u>Demographic</u>													
Income (high vs. low)	-0.32 (-12.47, 11.83)	0.957	0.194										
Employed (employed vs. not employed)	-16.55 (-26.82, -6.28)	0.004	0.897	-14.60 (-27.93, -1.27)	0.033	-18.38 (-31.97, -4.78)	0.009	-16.74 (-30.72, -2.76)	0.020	-3.78 (-20.30, 12.74)	0.645	1.64 (-15.37, 18.63)	0.846
Education (tertiary vs. less than tertiary)	8.37 (-2.71, 19.46)	0.131	0.873										
Age (years)	-0.11 (-0.83, 0.61)	0.752	0.217										
<u>Health-related</u>													
Time since diagnosis (>18mths vs. <18mths)	0.10 (-12.78, 12.99)	0.987	0.051										
Time since treatment (>12mths vs. <12mths)	-3.49 (-27.85, 20.86)	0.768	0.193										
Mastectomy (yes vs. no)	-9.55 (-24.57, 5.48)	0.204	0.091										
Chemotherapy treatment (yes vs. no)	1.32 (-10.43, 13.07)	0.818	0.233										
Radiation treatment (yes vs. no)	8.48 (-12.63, 29.59)	0.415	0.235										
Endocrine treatment (yes vs. no)	-6.53 (-17.97, 4.90)	0.249	0.003	-0.24 (-12.45, 11.96)	0.968	-1.83 (-15.33, 11.66)	0.786	-26.90 (-42.03, -11.77)	0.001	-1.60 (-15.60, 12.42)	0.820	-25.06 (-41.13, -9.00)	0.003
Cancer stage (0/1 vs. 2)	-14.28 (-36.10, 7.54)	0.190	0.783										
Chronic health conditions (none vs. ≥1)	9.32 (-2.97, 21.61)	0.130	0.337										
BMI (kg/m ²)	1.23 (-0.34, 2.81)	0.118	0.436										

^a Units = mean difference in levels of the baseline predictor variable associated with mean change in MVPA (mins/day) from baseline as reported in the table, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment ^b Units = mean difference in levels of the baseline predictor variable associated with mean change in MVPA (mins/day) from baseline between follow-up timepoints as reported in the table, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment

Appendix 7.I: Overall associations and timepoint interactions of baseline demographic and health-related characteristics with changes in energy intake, and differences in these associations between the follow-up timepoints

	Overall association		Timepoint interaction	6MΔ ^a		12 MΔ ^a		18 MΔ ^a		12MΔ-6MΔ ^b		18MΔ-12MΔ ^b	
	β (95% CI)	p		p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	Mean (95% CI)	p	
<u>Demographic</u>													
Income (high vs. low)	-953 (-2043, 137)	0.084	0.911										
Employed (employed vs. not employed)	-695 (-1738, 348)	0.180	0.692										
Education (tertiary vs. less than tertiary)	-164 (-1039, 712)	0.702	0.161										
Age (years)	-8 (-66, 50)	0.779	0.459										
<u>Health-related</u>													
Time since diagnosis (>18mths vs. <18mths)	-510 (-1568, 548)	0.328	0.497										
Time since treatment (>12mths vs. <12mths)	-1968 (-3836, -99)	0.040	0.009	-878 (-2786, 1030)	0.355	-2784 (-4804, -765)	0.008	-3118 (-5188, -1048)	0.004	-1906 (-3405, -408)	0.014	-333 (-1934, 1267)	0.676
Mastectomy (yes vs. no)	299 (-963, 1562)	0.633	0.622										
Chemotherapy treatment (yes vs. no)	114 (-855, 1082)	0.810	0.268										
Radiation treatment (yes vs. no)	-658 (-1914, 599)	0.290	0.585										
Endocrine treatment (yes vs. no)	67 (-929, 1063)	0.891	0.366										
Cancer stage (0/1 vs. 2)	-1191 (-3124, 742)	0.217	0.099										
Chronic health conditions (none vs. ≥1)	-256 (-1294, 783)	0.614	0.782										
BMI (kg/m ²)	-19 (-116, 154)	0.771	0.751										

^a Units = mean difference in levels of the baseline predictor variable associated with mean change in energy intake (kJ/day) from baseline as reported in the table, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment ^b Units = mean difference in levels of the baseline predictor variable associated with mean change in energy intake (kJ/day) from baseline between follow-up timepoints as reported in the table, estimated from mixed models, adjusted for baseline values, age, income, time since diagnosis, and chemotherapy treatment